

MIT's Magazine of Innovation

Technology World Changing Ideas Review

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are creating technologies
for a shrinking planet.
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around the globe. p42



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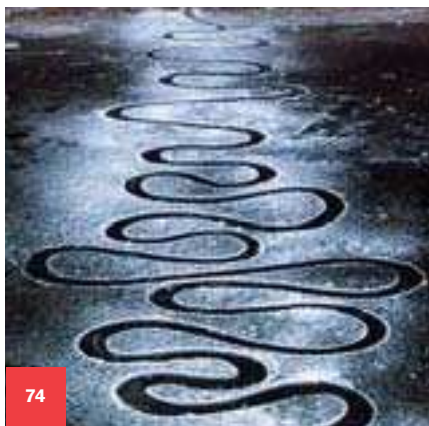


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This month, *Technology Review* steps outside the United States to find out what seven of our international partners believe to be their countries' most important emerging technologies.

Our website offers still more reports: technologyreview.com has reached out to reporters in China, England, and Korea in search of stories that explain the state of technology around the world. You'll find, for instance, a story by Aleks Krotoski about the battle between the United States and the European Union over the disposal of used electronics.

Some of these global stories will be set against the backdrop of the TR Large-Cap 100 and TR Small-Cap 50 indices (www.technologyreview.com/trindex), which track the most powerful innovators and the up-and-comers in 10 innovative industries in the global economy.

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Let's Go Dutch

AROUND 982 C.E., a Viking called Erik the Red discovered two clement fjords that ran into the ice mass of Greenland. On the lower slopes of the fjords there were green pastures; above, dark forests. It looked a little like Norway. Within a few generations there were 5,000 Norse colonists living in Greenland. They built a cathedral, traded walrus tusks for European luxuries, and farmed cattle as they had at home.

But Greenland is not Norway. It is desperately inhospitable. Consider, for example, how the colonists raised cattle: they built low barns in which they lived with their cows for nine months of the year. Each cow was kept in its own tiny stall. The Viking cows were dwarves, just over four feet tall. During winter, they were fed hay the colonists harvested during the short summer. After bad harvests, the hay would run out. Then the colonists would force the cows to eat seaweed, which made the cows sick. When the ice melted in May, the cows were too weak to walk; they were carried outside to eat the new grass.

It ended badly. The colonists cut down all their trees; the thin soil eroded; the hay harvest shrank and with it the Vikings' herds; the Little Ice Age of the Middle Ages made the winters longer and the seas impassable; one year the trading ships didn't show—and, after 500 years, the Greenland Norse just vanished from history.

Jared Diamond, a professor of geography at the University of California, Los Angeles, tells the story of the Greenland Norse in *Collapse: How Societies Choose to Fail or Succeed*, published earlier this year, and asks, Why did the colonists raise cattle at all? His answer is depressing: because in Scandinavia, cows were proof of wealth. Diamond's thesis, traced from Easter Island to modern Los Angeles, is that environmental strategies that work for a society at one time and place may be maladapted when circumstances change. If people won't adopt new strategies, if their environment is fragile and deteriorates, their society collapses.

Diamond is famous for an earlier book, *Guns, Germs, and Steel: The Fate of Human Societies*, which won the Pulitzer Prize by arguing that European civilization triumphed through geographical luck. *Collapse* has become a sensation, too. But at 575 pages, *Collapse* is long, life is short, and most commentators have grappled not so much with the book itself as with shadows of the book—in particular, with a simplistic summary Diamond published in the *New York Times* on New Year's Day, 2005, titled "The Ends of the World as We Know Them."

Environmentalists liked the summary and, therefore, *Collapse*,

because they thought it served the cause; likening our own time to the periods preceding previous historical collapses, Diamond declared, "We can't continue to deplete our own resources as well as those of much of the rest of the world." Conservative commentators have been uniformly hostile to what *they* think the book is about; they complain that Diamond does not understand "the tragedy of the commons"—that is, the phenomenon whereby commonly shared resources are undervalued and, very frequently, ruined by those who use them. In short, *Collapse* has been drafted into the battle between neo-Malthusians, who believe our economic life is wickedly destructive and must be constrained by governments, and Cornucopians, who think wealth can grow indefinitely and who adore the unfettered power of markets.

This is a pity, because the book is more ingeniously argued and profoundly researched than Diamond's summary of it suggests. The book's prescriptions, for instance, are pragmatic; Diamond understands that useful environmental regulation occurs only after complex calculations of costs and benefits. *Collapse* also considers and dismisses the tragic commons by demonstrating that some resources cannot be owned. But about technology itself, Diamond is less convincing.

In *Collapse*, Diamond describes himself as being a "cautious optimist"; really, he is gloomy. He writes, "Our world society is presently on a non-sustainable course." He dismisses technology's ameliorative powers, writing, "All of our current problems are unintended negative consequences of our existing technology." But Diamond does not fully understand technology. The collapse of the Greenland colonies was a technological failure: the Norse did not adopt technologies within their grasp, like fishing or silviculture, to their new environment. In this, we are a little like the Norse: oil companies now possess the technologies to drill with limited environmental impact, but for a variety of reasons are not required to do so (see "*Wild Profits*," p. 74). But more, technology also learns and evolves. The Norse scarcely knew how bad things were, and their technologies were very primitive. We know more about our environment and our technologies are more powerful. Perhaps Viking farming is not a very good metaphor for our environmental predicament.

The last chapter of *Collapse* is titled "The World as a Polder." Diamond explains how the fields of the Netherlands, reclaimed from the North Sea, have taught the Dutch that they share a common fate. Holland, he says, is a model for global sustainable development. So it is. Communitarianism may be the necessary condition of environmental action. But what Diamond does not add is that the polders of the Netherlands were a technological innovation. In this month's "Global Perspectives" package, we explain how the Dutch engineered their country into existence (see "*The Netherlands*," p. 51) and how they hope to sell new environmental technologies to a planet that needs them. The same package describes how different nations are working on other technologies that could save the world. We needn't collapse. Write to me at jason.pontin@technologyreview.com. ■

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FOREVER YOUNG

While reading Sherwin Nuland's portrait of Aubrey de Grey ("Do You Want to Live Forever?" February 2005), I couldn't help but imagine how Nuland might have portrayed a budding Newton, Darwin, or Einstein. My guess is they would also get painted as brilliant but wrongheaded. Just for fun, let's assume de Grey is right and that somehow all the biological interactions among the seven agents of death work in some miraculously advantageous way, paving the way for our great-grandchildren to choose whether they want to extend life indefinitely. Even if society sanctions extension, innumerable questions arise about temporal issues. Unless our feeble prophetic abilities are considerably enhanced, the horizon of our judgment will be no match for the life span de Grey envisions. Meanwhile, Darwin must be wondering how long it will take Extenders to out-survive individuals sufficiently humble to make way voluntarily for a next generation. Then what?

William E. Cooper
President, University of Richmond
Richmond, VA

Visionary thinking is often considered to be the dream of fools. But great strides can be made by paying attention to people like Aubrey de Grey. I applaud de Grey's courage, commitment, and audacity for shouting his ideas to the world. Even if those ideas do not unfold the way he envisions, the fact that this man of elegant thoughts and words *has* a vision, an idea of how humanity can get from point A to point B, may help to answer the age-old question regarding the limits of life itself.

Donna Manobianco
Mano Nanotechnologies
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I count myself in the mainstream of scientific aging research and I think the problem of life extension is far more vexing than does Aubrey de Grey. In fact, his plan

for extending human life does not account for several recent scientific discoveries. Some of these discoveries should give the immortalist or transhumanist particular discomfort, as they suggest that de Grey's approach does not address the primary, and maybe the most difficult to control, aspect of aging: entropy, i.e., the widespread loss of order and information.

Many of the factors that likely guide and regulate cellular differentiation, genomic stability, and cellular information content have not yet been identified. And we are expected to have full control of these extremely complex processes within the next 20 years? While such an achievement is not impossible, we are nowhere near the engineering phase, since we do not clearly understand the nature of the problem. Obviously, writer Sherwin Nuland and editor in chief Jason Pontin share a single attitude toward life extension: if it is conventional, it is good. Nuland claims he doesn't want to live excessively long, just a really long time for a human. From Pontin's comments, it seems that he wishes this for himself as well. So this is how they feel—for now. Once others live beyond the current upper limit, then they'll want to do it too.

While de Grey has compiled some evidence to support his theories, it is far from sufficient to tackle the problem. Nevertheless, at least he is trying—very hard—to do something noble and worthwhile: he is attempting to advance the cause of humanity. But he cannot succeed if he continues to pretend that his fellow scientists don't agree with his theories out of ignorance. Nobody, not even de Grey, is above the normal scientific exchange in which unpleasant or unanticipated facts must be accounted for by modification of existing theory. It is not enough to dismiss the messengers as being too "ignorant" to understand these brave and advanced conjectures.

Preston Estep III
President and CEO, Longevity
Waltham, MA

AUBREY DE GREY—TROLL?

I feel I must remark on the almost comically ad hominem tone of Jason Pontin's editorial ("Against Transcendence," Feb-

ruary 2005). Pontin adopts the desperate strategy of clutching at one hypothetical shortcoming of a postaging world (cognitive ossification); declaring it as a fact; rushing to another topic before the reader can question whether it will happen at all or, even if it did, whether that is worse than condemning 100,000 people a day in perpetuity to an unnecessarily early death; impugning my credentials by calling me a computer scientist despite my extensive publication record in biogerontology; insinuating that my publicizing of my predicted timescales for progress is irresponsible, without saying why; casting aspersions on my lifestyle and appearance; and concluding with an aphorism as absurdly evidence free as one can imagine (that "aging is the condition on which we are given life"). People know what publications to buy if they want to read that sort of logic; I didn't think *TR* was one of them. Of course, this is the level of rationality that many educated people descend to when trying to make excuses for aging, but that is hardly a justification.

Aubrey de Grey
Cambridge, England

Opinions differ as to whether antiaging medicine will or should exist in the future. Aubrey de Grey favors it; Sherwin Nuland does not. Both are entitled to serious consideration of their views. Neither deserves to have his sanity questioned on the cover of *Technology Review* ("Is he nuts?") or to be described as a "troll." The possibility that aging can be slowed, stopped, or reversed is not in the same category as the design of perpetual-motion machines. It is more like the possibility of flight before the airplane. Some single-celled organisms, while not immortal, do not age. Someday it may be possible and desirable to reverse human aging.

Henry R. Hirsch
Department of Physiology
University of Kentucky
Lexington, KY

Your attack on Aubrey de Grey is irrelevant to the patronizing view that you wish to project of a lone, isolated, visionary evangelist whose brilliant mind should be better employed on other more "appropriate" projects. So I wish to disabuse your readers that Aubrey is alone in his convic-

tions. The Gerontology Research Group, founded in 1990, is an international group of 130 scientists and physicians, all of whom are dedicated to slowing and then reversing human aging in the next 50 years. Aubrey is a member and has been an invited speaker to our group. I have personally followed this vision, since founding a prior organization dedicated to that goal in 1960. Moreover, I would hope that you reconsider your antitechnology stance ("even if it were possible to 'perturb' human biology in the way de Grey wishes, we shouldn't do it"). The Wright brothers would not have flown if they did not believe hard problems were worth pursuing.

L. Stephen Coles
Los Angeles, CA

Shame on you for your personal attack on Aubrey de Grey. I happen to agree with you that his outlook on defeating aging is far-fetched and even undesirable. However, when you try to disparage him for his attire ("dresses like a shabby graduate student"), his hair ("Rip van Winkle's beard"), his lack of children, or what you believe to be his social life, you lose credibility. Some of our most accomplished scientists and inventors have had many of the characteristics you attribute to de Grey. Was Einstein also a troll?

Alex Kotlarchyk
Boca Raton, FL

Calling Aubrey de Grey a troll does nothing to address any flaws in his research. The way a man dresses or the number of his children has nothing to do with the validity of his work. And so what if de Grey is only a computer support technician to a research team? When Einstein published his three seminal papers in 1905, he was only a patent clerk. De Grey has no children? Neither did Newton.

Geoff Dean
Surrey, British Columbia

JASON PONTIN RESPONDS:

When I called Aubrey de Grey a "troll," I was alluding to a famous remark by science fiction writer Bruce Sterling, who said, "People who take [transcendence] seriously end up turning into trolls." It was *not* an ad hominem attack—that is, a

rhetorical device where the writer discredits his opponent's argument by trashing his person. I was arguing that when technology appropriates the transcendental, and abjures humanist concerns, it becomes science fiction. I was pointing out that the man who wants to transcend death has a life that most of us would consider sadly circumscribed. I meant: what does de Grey know?

TAKING TERROR OFFLINE

David Talbot's story ("Terror's Server," February 2005) was the kind of rambling, analysis-free hand-wringing we came to expect from the mainstream press in the mid-1990s. Talbot's main point—that terrorists are using the Internet—is obvious. Terrorists are also using telephones, credit cards, textbooks, and mail-order catalogues to plan their attacks. The Net amplifies individual voices, be they the voices of civil-rights activists, cancer survivors, or terrorists. The real issue is not whether terrorists use the Net, but whether society is better off allowing individual voices to be so easily heard. Next time, address the issue directly instead of simply hiding behind the terrorism flag.

Bradley Rhodes
Mountain View, CA

THE UNOBSERVABLE MIND

I salute *Technology Review* and Roger Scruton for the review on the limited future of consciousness studies in neurobiology ("The Unobservable Mind," February 2005). However, I feel obliged to ask your readers not to throw the towel in yet. Our current understanding of the mind might be likened to a Greek philosopher's understanding of the physical world. We don't know, we can't know now, what the future of research will reveal about all aspects of the human mind in 10 years' time, much less 2,000 years. Neurobiology is but one of the emerging sciences and technologies that will impact our views of being human. Other technologies include advances in noninvasive monitoring of the brain, advanced robot technology, and advanced modeling of complex neural systems. One rea-

son that philosophers and scientists can't agree on many aspects of human cognition and consciousness is that they simply don't have empirical ways to compare their theories. That will change.

Jack Lynch
Cambridge, MA

RUNAWAY METAPHOR

Your October 2004 cover states that World Wide Web Consortium (W3C) founder Tim Berners-Lee is now "making Internet 2.0." Internet2, however, is the name of a consortium led by 207 universities working in partnership with industry and government to develop advanced networking technologies. The Internet2 consortium and W3C operate completely independently of one another.

Sir Timothy Berners-Lee
Director, World Wide Web Consortium
Cambridge, MA

Douglas E. Van Houweling
President and CEO, Internet2
Ann Arbor, MI

CORRECTIONS

Alteon, the company mentioned in the article "Do You Want to Live Forever?" (February 2005) for its work on antiaging substances, is located in Parsippany, NJ.

Our March cover story, "Tech and Finance 2005," misquoted Warren Packard of Draper Fisher Jurvetson regarding the nanotechnology market. Packard did not say that the market isn't ready for nanotech. He said that the public markets will always invest in real businesses with growing revenues, profits, or promise, and that quite a few nanotech companies are beginning to show these qualities.

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TEEN

STOLEN

CELL PHONE

LOST

BALD TIRES

LATE

LEAD FOOT

BAD BRAKES



YOU'RE NOT THE ONLY ONE WE'RE CONCERNED ABOUT.



You, your passengers, other drivers and pedestrians. These are the living, breathing reasons why we are committed to building some of

the safest vehicles on the road. This is why our Advanced Compatibility Engineering™ body structure on the 5-star-safety-rated Acura RL can help protect you and those in your car, and those in other cars as well. This is also why we developed the world's first crash simulator that replicates real-world crash motions. Tests that go beyond industry standards and into the realm of what can happen to real people in a real accident.

These are some of the motivating forces behind our performance technologies like Vehicle Stability Assist. One of many systems designed to help you avoid accidents through enhanced control and handling.

The innovations don't stop there. In fact, they will always continue. And until every distracted, sleepy, aggressive, inexperienced driver on the road no longer exists, your safety will remain our number one priority.

SAFETY THROUGH INNOVATION.



Each readme is an executive summary of a fatter story in the magazine, stripped to its logical bones. Each concludes with a call to action.

GLOBALIZATION

Let the World Innovate



It's no longer the American century. After giving the world the airplane, mass production, the transistor, the computer, the laser, and the Internet, the United States can feel proud. But as pundits love to remind us, we live in a global economy. It is becoming ever clearer that innovation is not the exclusive domain of the U.S. Indeed, it never really was: we can thank the British for the steam engine, the Japanese for just-in-time manufacturing and cheap, portable electronics, and the Germans for the earliest internal-combustion cars. And given current trends, it's increasingly hard to believe that the U.S. still dominates the development of intellectual property. As our "Global Perspectives" package (*p. 42*) shows, different countries are taking up the technological quest with a passion dictated by their own particular needs—and the resulting technologies,

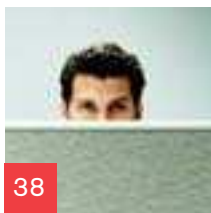
while addressing those needs, could have far-reaching applications in the wider world as well.

Just as each individual state in the U.S. is, in Supreme Court justice Louis Brandeis's famous formulation, a laboratory of democracy, so in the global community a growing number of countries have become test beds for technological innovation—prioritizing work that helps solve problems and make life better in their particular societies. Chile, for instance, is using biotechnology to breathe new life into its core industries: copper mining and salmon farming. South Africa faces unusual challenges in getting a largely poor population that speaks 11 official languages to use information technology. No wonder the country's top R&D lab is concentrating so much on systems that add language capabilities to computers. The Netherlands, which engineered itself into existence by reclaiming its geography from the North Sea, is becoming a developer of environmental technologies.

It's a division of R&D labor that could come in quite handy in the future. For now, the particular bacterium that Chilean researchers developed to scour more copper from the earth has only one application. But the concept of biomining could apply to extractive industries more generally. And if, as predicted, the planet's sea level rises over the coming decades as a result of global warming, the skills the Dutch have honed over the centuries could have worldwide applicability. The South African zeal for open-source programming illuminates a path that other countries might take to establish robust, indigenous software industries.

American technologists shouldn't fret about the globalization of innovation. It's a good thing. For the last few years, the R&D communities in the United States have elected to focus on military and security technologies that will make people feel safer. That's understandable, but while the United States dwells on protecting itself, countries with other priorities are moving ahead with many other technologies. As a result, R&D advances may

become more evenly distributed among nations. That's an unsettling thought for those of us accustomed to technological hegemony, but for the world, it's a better state of affairs. ■



BLOGS

Mean Media

Blogs are unmediated opinion—not journalism.

Bloggers like to deride MSM (the mainstream media, in their lingo) for not “getting it.” To avoid some of the sarcasm endemic to the new medium, we declare up front: *Technology Review* gets it. In fact, we love blogs so much that technologyreview.com is in part a blog site: we publish some of our most popular writers on blogs.

Thirty-two million Americans read blogs in 2004, according to the Pew Research Center. That is because blogs have great powers: they can spread the ideas of individuals faster, farther, and more cheaply than anything seen before. At their best, blogs are subversive, provocative, and fearless. Most fascinatingly, the ideas proposed on blogs have some of the characteristics of commodities in a free market. New postings are quickly valued by the blogosphere's economy: reliably stupid bloggers are not linked to by their peers, and no one visits their websites.

Bloggging is good for commerce. Corporations like Sun Microsystems are discovering that bloggging's transparency can help them reach customers in new ways. More than 1,000 of Sun's 32,000 employees—including the company president—write public blogs, many of which freely divulge the latest news about Sun projects. As our case study “Sun Microsystems: Blog Heaven” (p. 38) reports, Sun's executives have learned that bloggers connect with customers on a more authentic and human level than any marketing or public-relations expert.

Bloggging is good for the media, too. Political bloggers sometimes describe their movement as a kind of insurgency against MSM, and the emergence of a new cloud of media critics is, in fact, a welcome development. Various business and social pressures have made it harder for many journalists to report the news objectively. Bloggers can quickly call traditional journalists to task for their errors and biases.

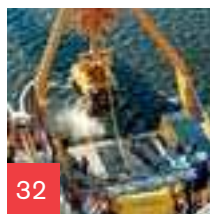
So much for the good. But blogs also have the power to focus writers' ire in ways that can destroy their targets.

Recently, we've seen the blogosphere's vindictive side. Conservative bloggers, offended by what they see as the arrogance and liberal bias of MSM, have hounded two prominent newsmen from their jobs. First, bloggers hastened the retirement of CBS news anchor Dan Rather for his preëlection coverage of what turned out to be dubious memos relating to President Bush's national-guard service. Then, in February, CNN's chief news executive, Eason Jordan, resigned “to prevent CNN from being unfairly tarnished” by bloggers' outrage at an incautious remark Eason made at the World Economic Forum annual meeting in Davos, Switzerland (see “Letter from Davos,” p. 78).

This relentlessness is in no way limited to conservative bloggers. In February, reporter Jeff Gannon was barred from attending White House press conferences after liberal bloggers picked up on a question Gannon asked President Bush in which he took a swing at Senate Democrats. The bloggers revealed Gannon's real name (James Dale Guckert) and that he had obtained press credentials as a representative of Talon News, a website sharing an owner with the conservative activist organization GOPUSA—not the kind of independent news organizations usually extended White House press privileges. While Gannon hardly had the stature of Rather or Jordan, the episode was a reminder that bloodthirsty bloggers can be found on both sides of the nation's political divide.

Perhaps all three men deserved their fates; maybe the blogosphere is to be applauded. But in each case, bloggers expressed an unseemly triumph after they got their man. It's hard to feel happy when bloggers turn into a digital mob. Blogs are powerful, but bloggers are rewarded for expressing extravagant opinions. And at least for now, their postings are not subject to the processes common for most stories produced by MSM: sober debate among colleagues, followed by reporting, line editing, copyediting, legal vetting, and fact checking.

Bloggging and the Internet must be credited for transforming the lofty castle of publishing into something like a public utility. But blogs can also be destructive and unaccountable. Readers would do best to enjoy blogs for what they are—reactive, unmediated, immediate opinion—and not mistake them for journalism. ■



ENERGY

Static Electricity

From California to New York's Long Island, power-grid innovation is at a near standstill.

Blame California. Deregulation of the electrical business in the Golden State in the late 1990s backfired so badly—contributing to massive price hikes, rolling blackouts, and eventually the ouster of Governor Gray Davis—that other efforts to restructure electricity markets in the United States seem permanently stalled. For example, rules making it easier for wholesale power generators to swap power went into effect in some states and not in others, leaving regional regulatory bodies with the power to block projects that might make the grid as a whole more reliable. “California just screwed that up so badly that everybody else is afraid of it,” says Sally Hunt, a power-industry consultant who advised the United Kingdom on the successful privatization of its own power industry in the late 1980s.

So it took no small amount of courage for TransÉnergie U.S., a subsidiary of Hydro-Québec, to push forward with a 1999 plan to lay a new digitally controlled transmission cable under Long Island Sound. Connecting the New England electrical grid to power-hungry Long Island, which lacks the on-island generating capacity to keep up with population growth, would fill an obvious market need. And because the cable would be bracketed on

both ends by advanced digital switches that precisely control the amount of power flowing through it, TransÉnergie would be able to stabilize regional power flows at peak times and bill utilities in Long Island or Connecticut for every kilowatt-hour of energy delivered, earning a quick return on its investment. (Metering power sent across the traditional power grid, which lacks such controls, is much more difficult.)

TransÉnergie obtained the necessary financing and permits, and by mid-2002 the cable was in place. But as contributing writer Peter Fairley explains in a case study, “TransÉnergie: Playing Two Power Games” (p. 32), that was only the beginning of the story. Politicians in Connecticut feared that the new Cross Sound Cable would damage oyster beds near New Haven and raise electricity prices across their state by draining cheap power to Long Island. Taking advantage of the state’s regulatory authority over infrastructure placement and a minor permit violation that arose during installation, Connecticut officials withheld the final permission to turn on the cable. If not for the catastrophic blackout of August 14, 2003—which left 50 million people in the dark across parts of the Midwest, Northeast, and Canada—supporters of the cable project, including Long Island utilities and federal energy regulators, might never have gathered the political ammunition necessary to force Connecticut’s hand and bring the cable into service.

The blackout was a lucky break for TransÉnergie, but the future of North American electrical grids shouldn’t be left to luck. Environmental concerns are one thing, but as long as individual states have the power to block construction or impose price controls willy-nilly, innovation will be squelched and the grid will remain a national embarrassment. Time-of-day pricing, for example, is an idea that can help distribute electrical loads across the grid more evenly by giving customers an incentive to buy power when transmission lines are less congested, but it can’t happen until state regulators allow utilities more freedom to vary their rates. And while TransÉnergie won its battle, the larger problem can’t be solved on a region-by-region basis. What’s needed is a top-down redesign of the nation’s power regulations. That would be scary and painful—but preferable to sitting in the dark. ■

Much of the controversy around BiDil is over the validity of using race as a medical shortcut to more exact biological categories.

BiDil, a new heart failure drug that will be marketed to African Americans, doesn’t help. By most estimates, it is an important medicine for heart failure, a disease that has reached epidemic levels in the United States. A clinical trial completed last year found that the pill reduced mortality among African Americans with heart failure by an astounding 43 percent. That’s great news for patients and cardiologists. And the drug has gained the backing of prominent medical groups such as the Association of Black Cardiologists. But if the U.S. Food and Drug Administration approves a race-specific pill, which it could do by mid-year, it will send a confusing message about what researchers are learning from population genomics—and raise troubling questions about how drug developers and physicians will use their growing knowledge of group differences.

As our feature “Race and Medicine” (p. 60) explains, much of the controversy is over the validity of using race as a shortcut to more biologically exact categories. Critics of BiDil point out that conventional racial groups are socially constructed categories that may have little relationship to genetic populations. Such categories are an uncertain guide to predicting which patients a drug will benefit, and using them as such ignores the complex lessons of population genomics. While tests done in the 1980s and early 1990s suggested that the treatment that would later become BiDil was, on average, more effective for black patients than it was for whites, the pill has not been tested in a large study of an ethnically diverse population taking current heart failure medicines. This matters because the reason for the racial differences in the earlier studies is not known. Without that knowledge, it is not possible to specify more precisely which individual patients, black or white, the drug will actually help.

If the FDA determines that the medical evidence justifies BiDil’s approval, the agency must approve the marketing of the drug. But as David Goldstein, director of Duke University’s Center for Population Genomics and Pharmacogenetics, argues in our feature, the agency should also mandate additional research to determine why the drug is so beneficial for some patients. That type of research will take money and time, but it will be well worth it to learn how to prescribe the medicine effectively and safely. As Goldstein puts it, “Race is never a precise guide. If you don’t have other information, you might be prepared to use race as an interim measure, but you shouldn’t treat it as the end of the story.”

Health-care professionals, biomedical researchers, and drug developers need to address the health disparities among different groups in the United States. By shedding light on why some drugs are more effective for certain groups, population genomics can play a role in narrowing those disparities. But all parties involved should also make it clear to the general public that genetic variations among groups are not a matter of black and white. BiDil might be an effective drug, but marketing medicines on the basis of race should not be the wave of the future. ■



BIOMEDICINE

Be Wary of Mixing Race and Medicine

Race-specific drugs are not the best way to address health disparities.

Population genomics is making rapid and remarkable advances in detailing the specific genetic variations that characterize people in different parts of the world. This information could provide, among other things, invaluable clues to why some medicines are more effective for particular ethnic groups. The worry is that genomic differences between groups will be misunderstood, and perhaps misused, to justify crude generalizations about races.

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Molecular Diagnosis 23

Quantum Leap 26

chatter

"Any company that feels threatened by **blogs probably feels threatened by the Internet."**

Jonathan Schwartz,
CEO, Sun
Microsystems, p. 38

"We do see [genetic] differences between populations. Unfortunately, race is a politically charged topic, and there will be **evildoers."**

Esteban Gonzalez
Burchard, professor
of medicine at the
University of California,
San Francisco, p. 65

"Steve Jobs used to say that HP was the inspiration for Apple's emphasis on innovation. **Fiorina never understood that you have to spend a little money to make money."**

A former HP Labs
employee, www.technologyreview.com

"Everyone is frightened that some Iraqi is going to put anthrax in our hamburger meat, and **security is along for the ride. But what's happening to the funding of other technologies?"**

Lita Nelsen, director of
MIT's Licensing Office,
p. 52

SOFTWARE

SnailMail 2.0

A new system could speed the mail and spare the postal worker

ANY EIGHTH GRADER who has finished Introductory Geometry can tell you that the shortest distance between two points is a line, but any postal worker who has hauled a mailbag along a 10-kilometer route can tell you that figuring out the shortest distance between 400 or more addresses is nearly impossible. Software aimed at doing just that recently made its commercial debut, in Denmark, with the hope of shortening mail delivery times and slashing postal-service costs.

The software, developed by Paris-based company Eurobios, takes a novel approach to what is known as the "traveling-salesman problem," which has stymied mathematicians for decades. The central challenge: adding a single new address multiplies the number of possible paths by the total number of addresses, so calculating an ideal route quickly becomes untenably time-consuming. (At present, using a standard PC to compare every possible route spanning just 100 addresses would take years.) Computer scientists have developed various programs that solve the traveling-salesman problem for



limited research purposes. But according to Dave Cliff, a complexity expert at Hewlett-Packard's Bristol laboratories in England, the vast scale of postal systems meant that "until recently it wasn't worth looking at computer methods, because the processing power wasn't there."

Indeed, a single regional mail-sorting area can be responsible for some 30,000 postal addresses—a number that would have hitherto defeated calculation, explains Cliff. Eurobios's software copes with the challenge in part by reducing the number of possible routes using heuristics, or rules of thumb, to rule out the impractical options. For example, unless a

"Last mile" distribution accounts for up to 70 percent of postal systems' total expenses.

street is very long, the system makes the assumption that mail going to all addresses on one side of the street will be delivered in one trip rather than multiple trips. Then, says Eurobios's Vince Darley, who created the program, the software employs an iterative technique to

optimize the routes. It starts off with a random set of routes and then makes a series of changes to them. By evaluating the outcome after each change and keeping those changes that shorten the route, while rejecting most of those that do not, the system quickly converges on a near-optimum solution.

In February, Post Danmark, the Danish postal service, began using the Eurobios software to determine the shortest routes for postal workers on the Danish island of Fyn. In trials, Eurobios's system has shown it can reduce the time it takes postal workers to deliver the mail each day by up to 10 percent. At the same time, the software cuts the distance that the delivery people travel by as much as 20 percent. That might not sound like much, but a typical European postal organization has between 10,000 and 50,000 delivery people, says Darley, which is one of the reasons that so-called last-mile distribution accounts for as much as 70 percent of postal systems' total expenses. Emptying each worker's mailbag just a few minutes faster could translate into millions of euros in annual savings for even one country, Darley says.

Duncan Graham-Rowe



Will Wright gives gamers command of the entire landscape.

SOFTWARE

Life Is a Game

Sims creator Will Wright faces his next challenge: everything

WHAT DO YOU do when you've made millions from the bestselling computer game of all time? Will Wright, creator of the Sims franchise, began collecting Russian space junk. The 45-year-old now has several backup control panels and computers from Russian spaceships. His prized possession: a global astrogator, a navigational computer with a tiny spinning globe inside. Wright appreciates the stuff as much for the science behind it as for the history. "We turned our noses up at the Russians," he says, "but I admire their approach to engineering and what they managed to do in space."

THOMAS BRENNING

And with his own feats of engineering and exploration, Wright has amassed his share of fans as well. Since cofounding his company, Maxis, in Orinda, CA, 18 years ago, he has transformed the stuff of ordinary life—from washing dishes to throwing hot-tub parties—into a cottage industry. Wright's most successful brands—SimCity, the urban-planning game, and The Sims, his people simulator—have sold roughly 54 million copies worldwide. Now, perhaps because of all those Russian spaceships, he's brewing up an intergalactic epic that's sure to be his most ambitious launch yet. "The theme," he says, "is everything."

Wright has long harbored such grand designs. At 13, he built a hydraulically powered robotic arm out of injection syringes. After five years studying architecture and engineering at various colleges, he dropped out to make games for the Apple II and Commodore 64. "I was fascinated by the ability to have this little microworld inside the computer," he says. "And that world had its own little rules and physics that you could interact with."

Applying urban-planning theories developed by MIT

Sloan School of Management professor Jay Forrester, Wright developed SimCity, a game that challenged players to build and manage their own thriving metropolises. Despite Wright's enthusiasm, however, his publisher balked at the game's open-ended, sandbox-style design. "They wanted a win/lose scenario," he says, "but it felt more like Legos to me than a standard game."

Wright stuck to his guns and in 1989 published the game for Mac and PC through Maxis (which is now based in Redwood City, CA, and owned by Electronic Arts). A near instant hit, SimCity became the foundation for a series of sequels and other simulations. It was

Wright's research on ant colonies for his game SimAnt, combined with his interest in the work of Christopher Alexander, an architect who argues that good building design always makes use of predictable patterns, that resulted in his biggest game yet: The Sims.

Released in 2000, The Sims puts gamers in charge of managing the most quotidian details of their virtual humans' lives—from lifting weights to taking showers. Success or failure is determined by how well or poorly a character's idiosyncratic desires are satisfied throughout the game. In The Sims 2, last year's sequel, characters can spawn children who share their personal characteristics—all the way

"I'm lucky to be at a point that I can propose crazy ideas and actually get where-withal to get resources behind them."

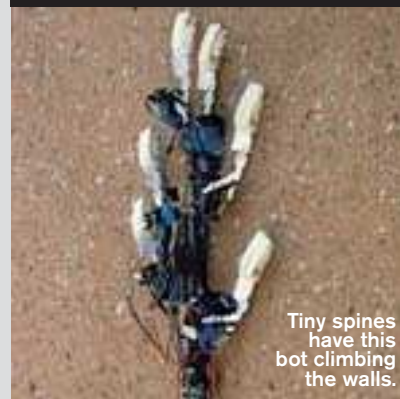
down to facial expressions. Players clearly like the added challenges; The Sims 2 sold one million copies in its first 10 days. Inspired by what he calls the "astounding" amount of original material, like homemade art and music, that gamers have incorporated into The Sims, Wright is now hard at work on his most epic and out-of-this-world sandbox game yet. He calls the as yet untitled project "a massively single-player game." This time around, players get the ultimate sim: life, the universe, and everything. As they create life from the cellular level all the way up to ecosystems and planets, players will be able to incorporate each other's material as well.

In his spare time, Wright's busy helping to conceptualize a future spaceflight exhibit for the Chabot Space and Science Center near his office in Emeryville, CA. And as the video game industry seems to depend increasingly on licensing characters and plots from other media, he's more determined than ever to keep brewing up his brave new worlds.

"I think this medium still has huge potential," Wright says. "I'm lucky to be at a point that I can propose crazy ideas and actually get where-withal to get resources behind them. So I feel a responsibility to push the envelope, whether I succeed or fail. The industry is in dire need of continued innovation."

David Kushner

Prototype



Roach Bot

You never know where cockroaches are lurking—maybe clinging to a pantry door or skulking on the underside of a commode. That creepy ability to cleave to almost anything was the inspiration for **SpinyBot II**, a six-legged, half-meter-long prototype spy robot capable of scaling vertical surfaces ranging from stucco to smooth concrete. Developed by mechanical engineer **Mark Cutkosky** and his team at **Stanford University**, the robot skitters around on feet that, like roach feet, grip climbing surfaces with tiny spines that can find pits and protrusions even in seemingly smooth terrain. Each of SpinyBot II's feet has 20 hardened steel spines whose tips are just 25 micrometers across. There are other climbing robots, which use everything from suction to adhesive pads to ascend. But they have trouble finding firm footing on dusty or irregular surfaces, and none of them is capable of hanging around securely for weeks on end. The Stanford prototype can do both, so it could augur not only new spy robots but also robots that inspect the outsides of buildings and, maybe someday, the surfaces of other planets.

Nanopatch

Tiny polymer patches on the surfaces of living cells might soon help drug developers and medical researchers see if drugs are reaching their targets or if viruses are mounting attacks. Such events cause changes to the membranes that enclose cells, but the changes are usually imperceptible with

continued on p. 23

TELECOM

Airborne Outbreak

In July 2004, computer security labs received samples of the Cabir worm—the first demonstration of a malicious software program capable of spreading from mobile phone to mobile phone.

As of February 2005, Cabir had been reported “in the wild” in 12 countries.

Approximately 12 cell-phone viruses, worms, or other types of malware now exist; they can infect phones when users install games or accept unsolicited files.

Mobile-phone viruses target smart phones, which will account for 20 percent of mobile phones worldwide by 2009.

In 2003, computer malware caused an estimated \$55 billion in damages.

95 percent of the world’s personal computers run on the Windows operating system; most computer viruses target Microsoft’s OS.

73 percent of smart phones use the Symbian operating system.

90 percent of U.S. households that are online employ PC virus protection.

NTT DoCoMo is the only mobile carrier that distributes antivirus software with all of its smart-phone handsets.

SOURCES: ABI RESEARCH, JUPITER RESEARCH, F-SECURE, MCAFEE, CAHNERS IN-STAT, FORRESTER RESEARCH



“Blogging isn’t just for people with strong opinions who want to reach a big public audience.”

INTERNET

Me.com

Online publishing can be an intensely personal affair. So says **Mena Trott**, cofounder and president of San Francisco-based **Six Apart**, which makes the weblogging software **Movable Type** and runs blogging services **TypePad** and **LiveJournal**.

How many bloggers are out there now?

There's a new Pew Center report that says eight million adult Americans have blogs. We think the global number might be twice that: we've got just under seven million ourselves.

Your competition includes Google and Microsoft. Nervous?

Actually, that's a good thing. It's hard for a company our size—we've got 80 people—to evangelize for blogging.

Why evangelize a technology that's already on everybody's hot list?

Our message is that blogging isn't just for people with strong opinions who want to reach a big public audience. Only six people in the world may want to know what you did for dinner last night, but if they're six people you know and care about, it's worth it. Most people don't actually want to be an instapundit.

Spencer Reiss



R&D

Microsoft Masala

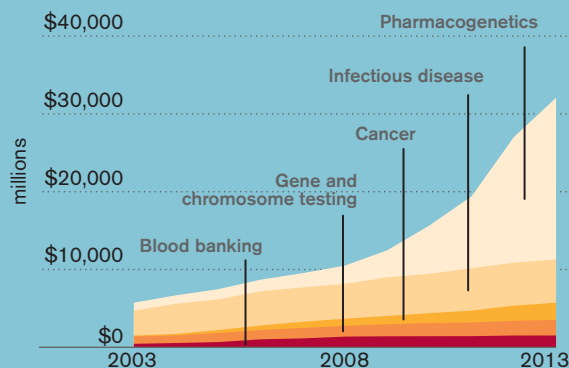
Microsoft knows that at least a few of the world's best software developers live beyond the confines of Redmond, WA. That's why **Microsoft Research**, the division charged with inventing the company's next generation of products, has set up satellite labs in San Francisco, Beijing, and Cambridge, England (see *"Microsoft: Getting from 'R' to 'D'."* **March 2005**, p. 28). Now the company wants to tap into the growing supply of high-tech talent in India: its newest lab opened in Bangalore in January. Led by Microsoft Research veteran **P. Anandan** (left), the lab will focus in part on geographical information systems that integrate satellite imagery, sensor data, and other inputs into a geographically indexed database that could be used to guide precision agriculture in India.

MEDICINE

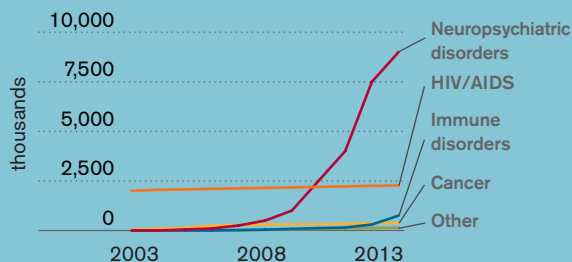
Molecular Diagnosis

Tests that analyze DNA or RNA are already helping doctors spot infectious diseases and determine a patient's likelihood of developing certain cancers. Researchers project that the next big market for these so-called molecular diagnostics is in pharmacogenetics—using a patient's genetic makeup to predict which drugs will most effectively treat a disease. Pharmacogenetic tests will likely be of particular use in handling neuropsychiatric disorders, which are extremely difficult to diagnose and treat.

Projected U.S. market for molecular diagnostics, by application segment



Projected number of pharmacogenetic tests conducted in the U.S., by indication



SOURCE: KALORAMA INFORMATION

continued from p. 21

standard monitoring techniques. **Raz Jelinek** of the chemistry department at **Ben-Gurion University** of the Negev in Beersheba, Israel, has found a way to attach 30- to 150-nanometer-wide patches of a color-changing polymer



Tiny patches on a human cell (left) glow red when a drug hits its target (right).

to human cells. If something perturbs the cells' membranes, the patches turn red and fluoresce. When, for example, Jelinek adds the anesthetic lidocaine to a sample of cells, the nanopatches affixed to them spark on like minuscule red Christmas lights. Jelinek hopes to soon develop a kit that would marshal the technology for use in both drug development and basic research.

Elevator Mus-eeek!

Anyone who's ever been stuck in an elevator knows how hard it can be to get help. But soon elevators should be able to lend a sympathetic ear, automatically detecting calls of distress. **Ajay Divakaran** and his colleagues at the **Mitsubishi Electric Research Laboratories** in Cambridge, MA, have developed a system that analyzes sounds' characteristic frequencies. The system is trained with typical elevator sounds—people talking, bags rustling, and so forth. Once in operation, it will compare



noises in the elevator against the acoustical signatures stored in its comprehensive list of known

sounds, raising an alarm if it fails to find a match. One of the system's functions is to detect attacks, says Divakaran, since even when elevators are equipped with video cameras, buildings often lack the personnel to monitor their video feeds. One remaining problem, says Divakaran: the system doesn't yet distinguish between a scream for help and a child throwing a tantrum.

TRANSPORTATION

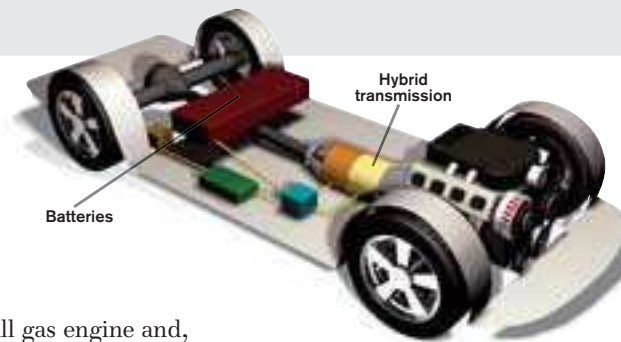
Gas-Guzzling Hybrids

Big engines get a green sheen

IN DECEMBER, GENERAL MOTORS and DaimlerChrysler showed off the technology at the heart of their recently announced hybrid-car partnership. The companies said that the contraption—a transmission packaged with two electric motors—would be in vehicles for sale in 2007, boosting their fuel economy by 25 percent. GM's announcement claimed it would "advance the state of hybrid technology in the industry." But the system will, in the end, produce an SUV that averages about 20 miles per gallon instead of 16; the Toyota Prius hybrid averages 55.

Still, experts say the new technology is a real advance. It's just not one aimed at changing the gas guzzler culture. GM and Daimler have built a hybrid system that's geared to squeezing a few extra miles per gallon from the big engines inside beefy pickup trucks, SUVs, and luxury sedans.

The Prius has a small gas engine and, overall, leans significantly toward the electric side of the hybrid equation. An electric motor propels the car at low speeds and works with the gas engine at higher speeds. The catch: much of the motor's electricity is generated by a second motor tethered to the gas engine, a process that's only 70 to 85 percent efficient. That's a good bit worse than the 98 percent efficiency with which a gasoline engine can transfer its torque to the road when only the gears of its transmission mediate. This loss is often not a big problem, since at low speeds, the gas engine is less efficient at producing torque. But when, say, the car is pulling a heavy load or traveling at highway speeds, it would be better for the gas engine to do the work directly. And trimming that loss of efficiency becomes more important when the engine is larger.



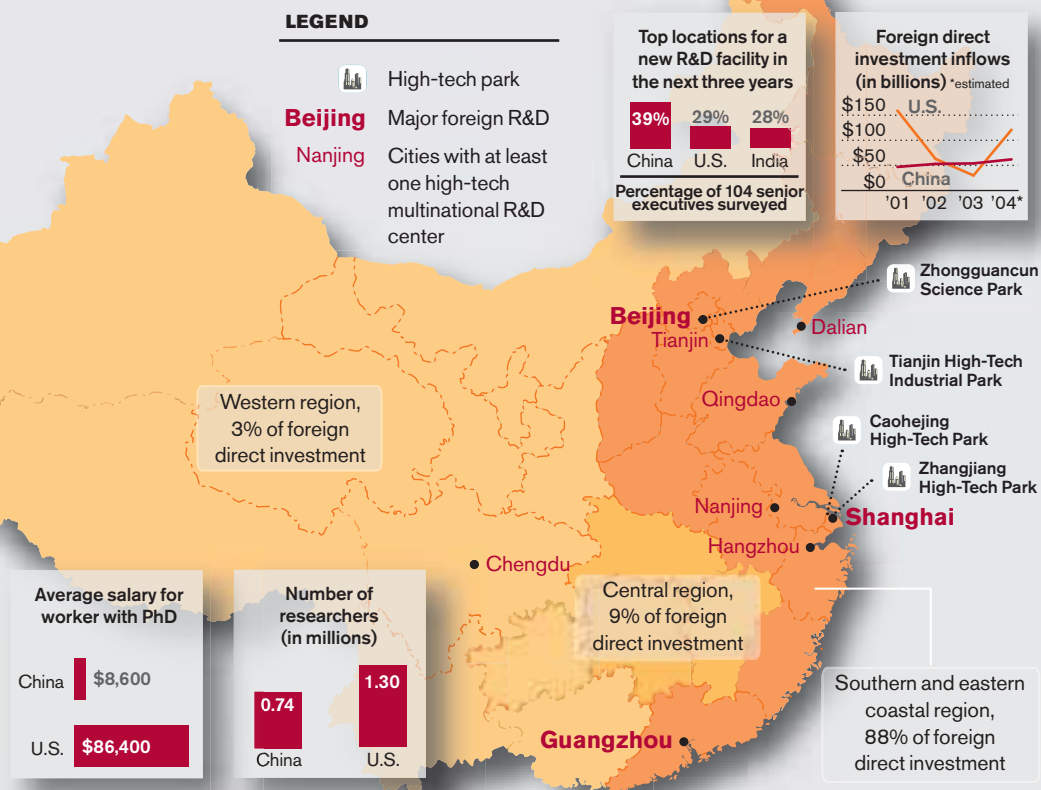
Enter the GM-Daimler transmission. The eight-cylinder engines it will be paired with feature "displacement on demand" technology, which shuts down individual cylinders at steady or low speeds. Its control systems put more emphasis on direct use of the gas engine, but in ways that keep it operating at peak efficiency, depending on how many cylinders are in use. And with an additional set of gears, the control systems can transfer nearly all of the engine's torque to the asphalt when the efficiency numbers call for it. "This is the next contribution to a radical change in the way drive power is provided," says Thomas Keim, an engineer at MIT's Laboratory for Electromagnetic and Electronic Systems. If only its impact at the pump were more radical.

David Talbot

R&D

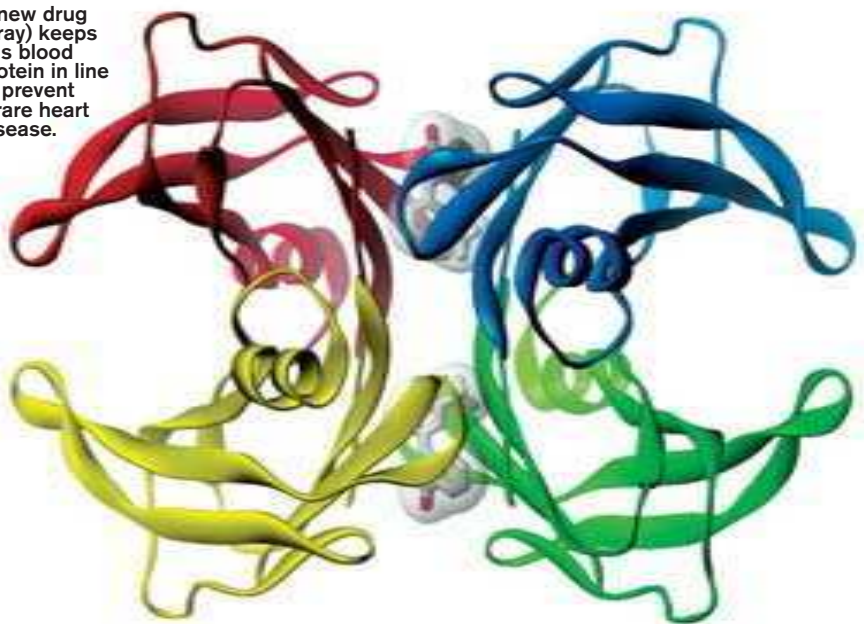
Made in China

There are now around 600 foreign-owned R&D centers in China, up from about 400 in 2002. The centers are concentrated primarily in the southern and eastern coastal region, which receives 88 percent of China's foreign direct investment. Last year, Roche, Nokia, Siemens, Ericsson, and Novo Nordisk all established new Chinese R&D outposts. One reason for China's appeal: it's second only to the United States in its number of researchers, and Chinese PhDs work for substantially less than their U.S. counterparts.



SOURCES: ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT, U.S.-CHINA BUSINESS COUNCIL, CHINESE MINISTRY OF COMMERCE, CHINA KNOWLEDGE, UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT, ECONOMIST INTELLIGENCE UNIT, PEOPLE'S DAILY, U.S. CENSUS BUREAU, ZHAOPIN.COM, CITY, REGIONAL, AND COMPANY INFORMATION

A new drug (gray) keeps this blood protein in line to prevent a rare heart disease.



STARTUP

Shaping Up Proteins

Targeting misfolded proteins could usher in a brand new class of drugs

IN THE MID-1990s, as the mad-cow-disease scare spread across Europe, scientists were beginning to accept a controversial idea: perhaps this contagious brain-wasting ailment was caused not by a virus or bacterium but by a protein already found in the body. Subtle changes in the shape of the normally benign protein could be enough to transform it into a deadly agent that turned the brains of cows and a few unlucky beef eaters into mush. Stranger still, researchers were beginning to find that other misshapen proteins were at the root of common ailments like Parkinson's disease, Alzheimer's disease, diabetes, and even cancer.

It was around this time that two of the leading scientists studying shape-shifting proteins—Susan Lindquist, then at the University of Chicago, and Jeffery Kelly of the Scripps Research Institute—began discussing the potential of drugs that prevent proteins from getting bent out of shape and unleashing their toxic effects. “I would say that within our first two conversations, we talked about starting up a company,” says Lindquist, who is now at MIT. And so was born the idea for FoldRx Pharmaceuticals.

But the Cambridge, MA-based company didn't actually get off the ground until December 2003, shortly before Lindquist left her post as director of MIT's Whitehead Institute for Biomedical Research. Despite that lag, FoldRx is still one of only a few startups developing drugs that target misshapen—or misfolded, as researchers typically call them—proteins.

Having captured \$16 million in first-

COMPANY:
FoldRx
Pharmaceuticals
HEADQUARTERS:
Cambridge, MA
AMOUNT INVESTED:
\$16 million
LEAD INVESTOR:
HealthCare Ventures
KEY FOUNDERS:
Susan Lindquist, MIT; Jeffery Kelly, Scripps Research Institute
TECHNOLOGY:
Drugs for Parkinson's and other diseases that prevent the toxic effects of improperly folded proteins

round venture capital financing last December, FoldRx is now moving quickly. The firm has already made plans to start human testing later this year of a drug for a genetic disease called familial amyloid cardiomyopathy, which afflicts an estimated 150,000 Americans. It strikes when a misfolded blood protein accumulates in heart tissue, causing the heart to stiffen and eventually fail. FoldRx's experimental drug is de-

signed to bind to the protein just after it is manufactured in the cell and prevent it from misfolding. The company hopes to take the drug all the way through the regulatory approval process on its own, an expensive proposition for a small firm. A time-consuming one, too: the process typically takes at least seven years to complete.

With much of its resources devoted to developing drugs for familial amyloid cardiomyopathy, FoldRx may decide to partner with larger pharmaceutical companies for its other drug-development programs. Chief among them is an effort focused on Parkinson's disease, which affects more than half a million Americans. Inside the brain of a Parkinson's patient, researchers believe, misfolded proteins clump together, triggering the death of brain cells and causing the tremors associated with the disease. A drug that targets the protein “would be really amazing,” says Anne Young, a Harvard Medical School neurology professor and Parkinson's-disease expert at Massachusetts General Hospital. “It could potentially stop the progression of Parkinson's or slow it down a huge amount. It would be completely novel.” FoldRx hopes to start animal testing of promising drug candidates this year.

One major obstacle that the company could face as the Parkinson's-disease project progresses is that it's difficult to monitor protein clumping in the brain, says Chris Dobson, a chemistry professor at the University of Cambridge whose own startup, Zientia, which is based in Cambridge, England, is also developing drugs for protein-misfolding diseases but does not yet have immediate plans to begin human tests. Such monitoring could be important in evaluating whether a potential drug is actually working. Researchers have recently begun developing imaging and diagnostic technologies that could do the trick, Dobson says, but the work is still in its early stages and will have to proceed quickly in order to give researchers at both startups the tools they need to test their new drugs in humans when the time comes.

Misshapen proteins are at the root of Parkinson's disease, Alzheimer's disease, diabetes, and even cancer.

Corie Lok

Quantum Leap

SINCE 2002, WHEN quantum cryptography was first commercially launched as the new gold standard in secure communication, only a handful of particularly paranoid early adopters have subscribed to it. But now a breakthrough by Toshiba is promising to make the technology more competitive with traditional cryptography and push it into the mainstream.

Quantum cryptography allows two parties to send secret encryption keys to each other while testing to see if anyone has attempted to intercept them. The keys are sent, one photon at a time, over standard optical fibers; each photon represents a binary 1 or 0 . What makes the system so secure is that any attempt by an eavesdropper to intercept the photons will alter them—alerting the sender to a security breach. The problem: the hardware

Toshiba's solution is to send two signals. "Along with the single-photon pulse we send a second, brighter, guardian pulse," Shields explains. The guardian pulse provides a reference point for the receiving hardware, which automatically adjusts to ensure that the photon paths are

“Stability is an old issue with quantum cryptography,” says Grégoire Ribordy, CEO and cofounder of Id Quantique, the Swiss startup that was the first company to launch a quantum cryptography product. Id Quantique, which currently has about a dozen customers, uses a different method to get around the need for constant human attention. That method, however, limits the distance that a key-carrying light signal can travel to about 100 kilometers, and limits the rate of transmission to about 10 kilobits per second.

Duncan Graham-Rowe

Toshiba's system can operate 24 hours a day, seven days a week, without any human intervention.

A diagram of the solar system showing the Sun at the center, surrounded by concentric orbits. Planets are labeled: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Asteroids are shown between Mars and Jupiter. A 'NEW PLANET' is indicated by an arrow pointing to a dot on the outermost orbit.

Another planet has swum into human ken and Neptune loses its distinction of marking the frontier of the solar system....The discovery...consisted in photographing the planet through an extremely delicate lens, designed and used in accordance with a mathematical theory which pointed the way. It was a brilliant triumph for the scientific method as well as for American astronomy. The astronomers who participated in the discovery are C. O. Lampland, E. C. Slipher, J. C. Duncan, K. P. Williams, E. A. Edwards, and T. B. Gill. These men estimate that the new planet, yet unnamed, is 45 times as far from the earth as the earth is from the sun, but they have not yet determined its size beyond the fact that it is as large as the earth. (April 1930, p. 298)

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- **Marc Cecere**, Vice President and Principal Analyst, Forrester Research
- **Barbara J. Desoer**, Chief Technology, Service, and Fulfillment Executive, Bank of America
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Web Services Take Hold

WEB SERVICES HAVE graduated from buzzword to essential business tool. Web services are what happens when programmers use recently developed Internet standards to let software applications talk to each other. This means, for one thing, that companies can run business applications written in different languages, for different types of hardware, but transfer data between them without having to build expensive custom integration systems. It also means that a company can better integrate its own operations by allowing, say, its inventory systems to connect to its customer management system.

One example: IBM worked with Visa and its affiliated banks to create a Web services system for call centers. Now, instead of having to log credit card disputes twice—once for the bank, and once for Visa—agents log calls once and transmit the information directly to both Visa and the bank. That change has saved Visa

\$238 million after just three months, says Michael Liebow, director of Web services for IBM Global Services.

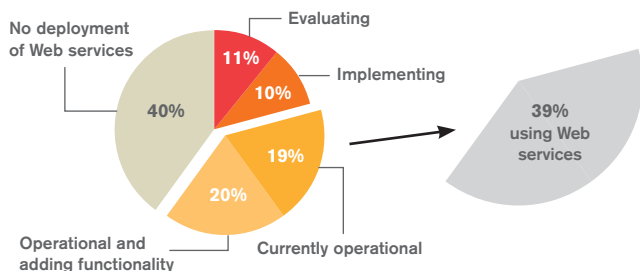
“Web services are unequivocally gaining traction within businesses,” says Whit Andrews, an analyst with market research firm Gartner. Analysts estimate that from 50 to 85 percent of large companies now use Web services. According to Gartner, 63 percent of enterprises deploying Web services are using them for internal integration projects, while the rest are connecting their internal systems to those of partners and customers.

Among companies using Web services, however, 59 percent spent less than \$100,000 on them last year, according to AMR Research. Nonetheless, the market for Web services creation, management, integration, and security will reach \$6.2 billion by 2008, according to the Radicati Group.

MARYANN JONES THOMPSON

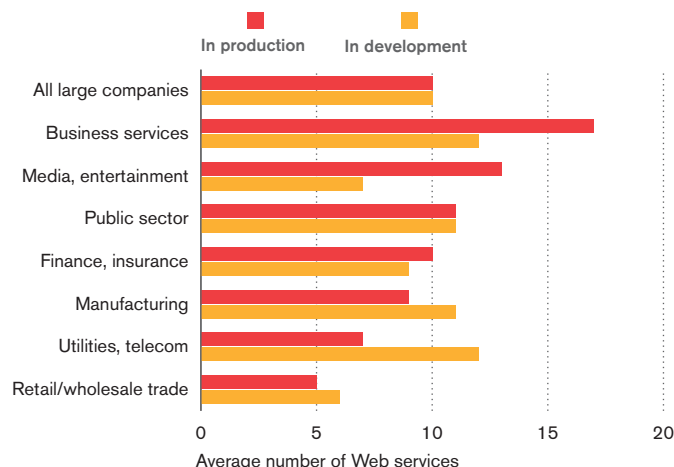
Web services usage in large U.S. companies

Many companies still balk at Web services' technological complexity and at the continuing disagreement over standards.



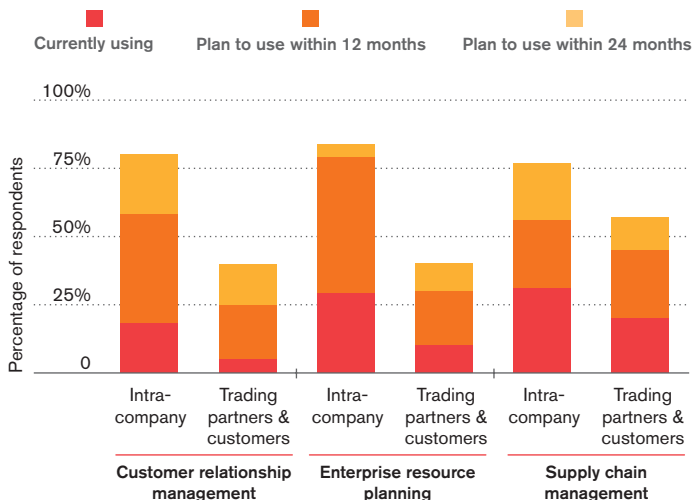
Web services usage by industry

Service industries lead in Web services deployment; retail and wholesale businesses lag.



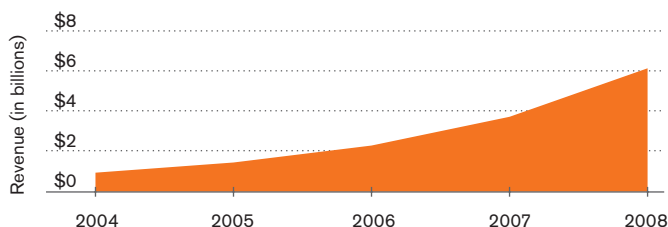
Type of Web services deployment

A recent survey shows that companies deploying Web services use them principally to integrate their own internal information systems.



Web services developer tools forecast

The market for Web services creation, management, integration, and security will reach \$6.2 billion by 2008.



SOURCES: AMR RESEARCH, GARTNER, FORRESTER RESEARCH, AND THE RADICATI GROUP

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Great Expectations

Deliver, or face the consequences

AS GO THE annual rites, the stock market spent January and early February rewarding companies that had lived up to their promises and exacting punishment from those that had not. The big news: on February 9, Carly Fiorina was booted out of Hewlett-Packard for failing to deliver on the promise of the HP-Compaq merger. If you'd been watching HP's stock, you wouldn't have seen it coming: it slid a mere 1.9 percent from January 7 through February 4, presaging nothing. But that was just the point: the company's board was tired of waiting for results. Its shake-up caused the largest one-day move in the stock in more than a year, a 6.9 percent gain.

The stocks of underperforming companies are more likely to fall than to rise, mind you. After coming up short in their fourth quarters, both Amazon.com and eBay suffered rampant selling. The online auctioneer lost nearly a third of its market capitalization over the four weeks ending February 4. Amazon was not far behind. Still, some companies began the year well. New it company Samsung Electronics led the charge, with perennial it company Apple Computer close behind. Sandwiched in between: video game maker Electronic Arts, which saw its quarterly revenue slip but still meet investor expectations in December, resulting in a stock price gain of 15.6 percent through early February. The company, whose stock has returned well over 1,000 percent in the last decade, might be inclined to quote Bonasera from *The Godfather*, who said, "I believe in America. America has made my fortune." And it wouldn't be inappropriate: on February 2, Electronic Arts announced that it was developing a video game of Francis Ford Coppola's masterpiece.

Duff McDonald

The TR Large-Cap 100 and Small-Cap 50 indices are updated daily online: www.technologyreview.com/trindex

TR Large-Cap 100

	% change 1/7-2/4	Total market cap (millions)
Energy	8.3%	\$1,213,137
Semiconductors and Equipment	5.1%	\$376,937
Aerospace and Defense	4.4%	\$225,722
Health Care	4.4%	\$221,360
Media	0.2%	\$488,325
Software and Services	-1.3%	\$527,418
Computers	-2.2%	\$739,214
Biotechnology and Pharmaceuticals	-2.4%	\$1,109,861
Telecommunication Services	-3.1%	\$793,629
Consumer	-10.6%	\$188,174

TR Small-Cap 50

	% change 1/7-2/4	Total market cap (millions)
Energy	14.6%	\$14,048
Aerospace and Defense	12.4%	\$4,813
Health Care	9.5%	\$10,009
Telecommunication Services	4.2%	\$3,602
Software and Services	4.1%	\$16,607
Computers	3.3%	\$18,224
Biotechnology and Pharmaceuticals	2.2%	\$11,274
Media	0.8%	\$11,975
Consumer	-6.8%	\$3,127
Semiconductors and Equipment	-13.9%	\$6,257

TR Large-Cap 100, Top Gainers

	% change 1/7 - 2/4	One-year % change
Samsung Electronics (Korea: 005930)	15.8%	-2.7%
Electronic Arts (Nasdaq: ERTS)	15.6%	54.4%
Apple Computer (Nasdaq: AAPL)	13.9%	262.0%

TR Large-Cap 100, Top Losers

	% change 1/7 - 2/4	One-year % change
eBay (Nasdaq: EBAY)	-28.8%	15.9%
Amazon.com (Nasdaq: AMZN)	-15.6%	-21.3%
Qualcomm (Nasdaq: QCOM)	-14.5%	31.1%

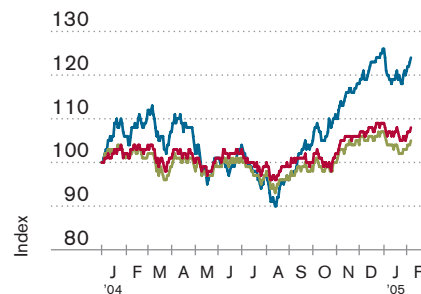
TR Small-Cap 50, Top Gainers

	% change 1/7 - 2/4	One-year % change
Macromedia (Nasdaq: MACR)	30.9%	14.6%
First Calgary Petroleum (Toronto: FCP CN)	21.4%	22.6%
Affymetrix (Nasdaq: AFFX)	18.8%	17.3%

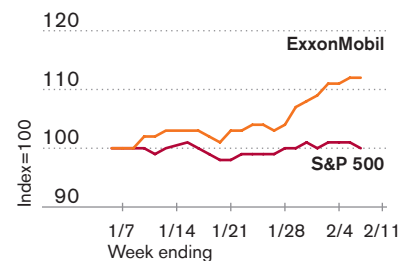
TR Small-Cap 50, Top Losers

	% change 1/7 - 2/4	One-year % change
Cree (Nasdaq: CREE)	-28.9%	-40.4%
Rambus (Nasdaq: RMBS)	-17.3%	-23.0%
CACI International (NYSE: CAI)	-13.5%	-21.6%

TR Stock Index Comparison



In Depth: ExxonMobil



You could almost see this one coming. Shares of ExxonMobil were hitting all-time highs in early February as investors celebrated the oil giant's fourth-quarter profit of \$8.42 billion—the largest quarterly profit ever reported by a U.S. company. This was humbling for analysts, who had expected earnings per share of \$1.07. Reported earnings of \$1.30 were more than 20 percent higher than that consensus.

SOURCES: STANDARD AND POOR'S CUSTOM INDEX SERVICES, TECHNOLOGY REVIEW, YAHOO FINANCE

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TransÉnergie: Playing Two Power Games

Laying a new transmission line
under Long Island Sound was easy.
Navigating the political waters wasn't.

ON A THURSDAY AFTERNOON last June, state troopers from Connecticut and New York fanned out on a manhunt. Their quarry: several of the dozen Connecticut legislators and commissioners with the power to make or break Massachusetts-based TransÉnergie U.S., a pioneer in advanced high-voltage power transmission owned by Montréal power utility Hydro-Québec. For two years, political squabbling had idled an innovative 40-kilometer underwater power line installed by TransÉnergie to strengthen the link between the Connecticut and Long Island power grids. On the Thursday in question, TransÉnergie, Long Island's power utility, and Connecticut regulators had finally found a way to end the impasse. All they needed to seal the deal were signatures from all 12 of those Connecticut politicians.

The manhunt marked the dramatic close to a saga that made TransÉnergie a poster child for the confusion that reigns in the U.S. power market. In the early 1990s, the U.S. Congress threw wholesale power markets open to competition, enabling state utilities to buy bulk power from generators located hundreds or thousands of kilometers away (much of New England and New York's power, for example, comes from Québec). But regional coordination of power grids to accommodate long-distance power delivery has stalled. All too often, coordination has



Sunk costs:
ships lay
TransÉnergie's
cable in 2002.

TransÉnergie U.S.

Headquarters: Westborough, MA

Length of transmission lines:
30,000 kilometers

Total value of North American assets:
\$12 billion

The case: TransÉnergie's new 330-megawatt power cable across Long Island Sound is part of a movement toward "merchant transmission" that could revolutionize the North American power grid. But before it could be brought into service, the cable was caught in a riptide of competing interests that pitted Connecticut against New York. Were it not for the largest blackout in North American history, the cable might still be dead in the water.

fallen victim to interests that stand to lose from increased competition; and federal law gives states the upper hand in regulating electrical transmission, thwarting the best efforts of power regulators in Washington. "It's really a mess," says Sally Hunt, a power-industry expert affiliated with National Economic Research Associates, a consultancy in New York.

TransÉnergie's project got caught in a tussle between Connecticut and New York. "We were stuck in the middle of a much larger policy debate," says TransÉnergie U.S. president Jeff Donahue.

What makes the gridlock tragic is that it's stifling the application of advanced transmission technologies that promise to not only facilitate power sharing across the continent's aging power grids but also make them more reliable. TransÉnergie's Cross Sound Cable is one of the first in a string of power lines that exploit digital switching, a technique that allows unprecedented control over electrical flows in the network while simultaneously filtering out dangerous spikes and sags (more on that later).

The benefits of the Cross Sound Cable were initially lost on Connecticut politicians, who believed that the cable would serve only to feed Long Island's seemingly insatiable appetite for energy at the expense of Connecticut's consumers and natural environment. Technical missteps by TransÉnergie deepened its problems in Connecticut, giving state officials license to use the company as a political whipping boy. But a very lucky break, in which TransÉnergie and its supporters shrewdly exploited the cable's advanced technology, turned the tables. When the August 14, 2003, blackout threw Long Island into darkness (along with much of the northern United States and Ontario), the Cross Sound Cable was pressed into service to help stabilize the grids. Ed Grilli, chief of staff for the Long Island Power Authority, says that August 14 set the stage for a political breakthrough: "Quite frankly, what saved us in the end was the blackout."

Six Feet Under

The pair of 10-centimeter-thick cables begins in a building located in New Haven, CT, connects to a set of digital power valves, travels beneath the Long Island

COURTESY OF TRANSÉNERGIE U.S.

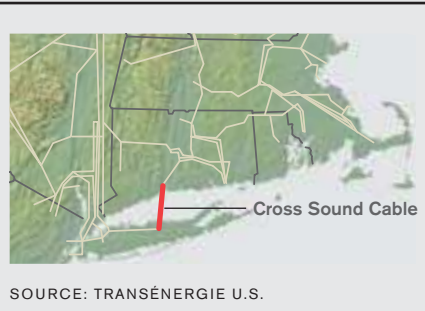
Sound—buried under approximately one to two meters of muck—and comes ashore 70 kilometers east of Manhattan to feed an identical set of valves located on the site of the deactivated Shoreham Nuclear Power Station, which stands in eerie silence as a symbol of the public concerns that crippled the U.S. nuclear-power industry. The \$6 billion plant was fully built but had never operated commercially when local opposition, led by then governor Mario Cuomo, forced its closure in the late 1980s. The Cross Sound Cable's greatest enemy was an equally popular politician from across the sound: Connecticut attorney general Richard Blumenthal. Like Eliot Spitzer, his better-known New York counterpart, Blumenthal is both an activist attorney general and a likely contender for the Democratic nomination to challenge his state's Republican governor in 2006. Grilli says that TransÉnergie handed Blumenthal a juicy issue, and the ambitious pol made the most of it. "They got swallowed up," says Grilli.

The Cross Sound Cable saga began in the late 1990s. Grilli's operation was desperate for electricity. Demand for power on Long Island grew larger every year, and reserve capacity was getting thin. After summer heat waves in 1999, power supply became a high-profile issue. The authority invited power producers to build new plants on Long Island, but it also wanted to access the relatively cheap power available in New England. TransÉnergie offered a deal the authority couldn't refuse: it would create a subsidiary, the Cross Sound Cable Company, that would build a line under the sound, at its own expense. The subsidiary, coöwned by Connecticut utility United Illuminating, would then rent capacity on the line to the authority. This would be the first such "merchant" line in the United States, and TransÉnergie knew how to exploit digital switching technology to make it work.

Electricity flows over power grids at the mercy of the laws of physics. As consumption levels shift from moment to moment, electrical energy follows the path of least resistance from generators to users. The result is that a power company's grid isn't limited to delivering electricity to its own local customers but can also, at any moment, become the unpaid carrier of power flowing automatically from high-

Strengthening the Northeast's Power Grid

The Cross Sound Cable supplies electricity to power-hungry Long Island.



supply areas to high-demand areas outside its own region. That makes building new power lines—which traditionally use alternating current (AC)—a very tough sell for an independent investor, explains Laurence Kirsch, a transmission expert with Madison, WI-based consultancy Christensen Associates. "When you build an AC transmission facility, lots of people get to use it without paying just because of how power networks work."

In contrast, TransÉnergie has precise control over the Cross Sound Cable. Those digital switches at the converter stations on either end, designed and built by Swiss power equipment firm ABB, consist of transistors sized for the grid's kilovolt power levels; acting much like valves, the switches on one end convert a specified quantity of the grid's AC power into direct current (DC) and send it down the line to be converted back into AC on the other end. The result is that the Cross Sound Cable Company can lease space on its line and then program the switches to deliver the specified kilowatt-hours of electricity. As on a private toll road, there are no free riders: "If people don't pay, we close the road," says Donahue.

The Federal Energy Regulatory Commission, which oversees wholesale power markets, welcomed TransÉnergie's proposal as a boon to competition in the New York and New England power markets. But Blumenthal was convinced that the cable was a bad deal for his state. He charged that the project was "anticonsumer and antienvironment." He wasn't far off base: economists generally agreed

that the cable would siphon off cheap power, lowering supply and raising prices in Connecticut. And to avoid interference with boat traffic and fishing, permits that were issued to TransÉnergie required that it bury its cables about two meters below the seabed, which meant plowing a trench through cultivated oyster beds in New Haven Harbor.

Blumenthal came out swinging, in both the media and the courts. He challenged a decision made by the Connecticut Siting Council, the state's overseer of power infrastructure projects, which had ruled in January 2002 that the long-term need to expand electric transmission capacity in the region outweighed any short-term cost to Connecticut consumers and temporary disruption of the oyster beds. Blumenthal also issued a series of press releases predicting that the Cross Sound Cable would cause "irreparable environmental damage while offering no benefit to Connecticut"—a stance that garnered a substantial amount of public support.

On April 9, 2002, a Connecticut Superior Court judge rejected Blumenthal's request for an injunction against the Cross Sound Cable Company, clearing the way for installation of the cable. But two months later, after technical blunders by the company, Blumenthal was back on top. The Connecticut legislature had passed a moratorium on consideration of permits for cross-sound infrastructure projects. And in May, while burying the cable below the sound, ABB struck rock in the seabed, which kept short sections of the cable shy of the minimum depths specified in the transmission company's permits. To operate, the company now needed amendments to the permits. But Blumenthal asserted in a legal opinion that granting them would violate the legislature's newly enacted moratorium. So for the next year and a half, TransÉnergie was trapped: it couldn't operate without new permits, and it couldn't get new permits with the moratorium in place.

Digging Out

August 14, 2003, was a dark day for many people in the United States—though not for officials at TransÉnergie. Just after 4:00 P.M., cascading outages starting in Ohio knocked out power to 50 million

Briefcase

people in Canada and the U.S., including many in Connecticut and Long Island. It was just what TransÉnergie and sympathetic officials in Washington needed to put the Cross Sound Cable back on track.

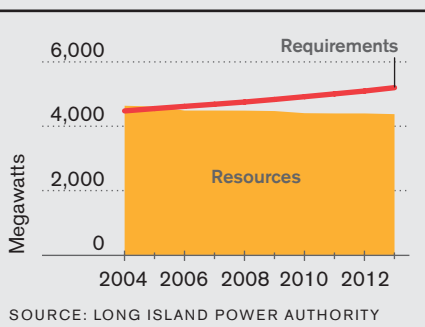
The crucial suggestion came from the Long Island Power Authority. Ed Grilli and the authority's chairman, Richard Kessel, asked their grid operators whether the Cross Sound Cable could help them get the lights back on. According to Grilli, they said it "absolutely would." Grilli contacted the office of New York governor George Pataki, who set up a conference call late that night with U.S. Department of Energy officials, grid operators in New York and New England, and Donahue, who is CEO of both TransÉnergie and its Cross Sound Cable subsidiary. Soon afterward, U.S. energy secretary Spencer Abraham issued an emergency order, and by early the next day the company had energized its cable. "We had always planned on being available if there was an emergency, so the facilities were left in a state where it wouldn't be difficult to turn them on," Donahue says. "Within 12 hours we were transferring power to Long Island, helping customers get energy—and most importantly, helping provide stabilization to the grid while the generators on Long Island were coming back on."

Abraham's emergency order was set to expire two weeks after the blackout, but he extended it indefinitely, arguing that the grid was in jeopardy until the cause of the blackout was determined. Abraham would not rescind his order until May 2004, after the Energy Department and Canadian investigators issued an exhaustive dissection of the blackout. By then, nine months of operating experience and a radically altered political environment had worked wonders for TransÉnergie.

Politicians, like most of us, tend to take electrical power for granted. The 2003 blackout stripped away this sense of security. Suddenly local and state officials were concerned about power grids' vulnerability to everything from lightning strikes to terrorism, which cast TransÉnergie's cable in a new light: according to Donahue, the cable's digital switches helped stabilize voltages on neighboring lines on 135 occasions between August 2003 and April 2004. Nine months of operation also proved that the cable was not

Power Forecast

Long Island's power demands will soon outstrip the on-island supply.



the dire economic or environmental threat that Blumenthal had predicted. Prices didn't rise dramatically, and no damage to the oyster beds was documented. Indeed, without the cable, Long Island would have had to pay an extra \$15 million to \$18 million for replacement power in 2004, according to Long Island Power Authority calculations.

On June 17, 2004, the Federal Energy Regulatory Commission warned Connecticut, the Long Island Power Authority, and TransÉnergie to settle their squabble within a week or face federal impositions they might all regret. Grilli says he picked up the phone and found the Connecticut regulators ready to talk. By deadline day they had a deal. Connecticut agreed to let the Cross Sound Cable Company operate while it determined how to finish burying the line. The Long Island authority agreed to replace an aging cable between Long Island and southwestern Connecticut. The authority, the Cross Sound Cable Company, and Connecticut Light and Power chipped in \$2 million apiece to an environmental trust fund to benefit the sound.

By the end of Thursday, June 24, all the Connecticut politicians had been located, the deal was signed, and the press releases began to fly.

Fixing the Rules

For TransÉnergie, the victory had come at a high cost—about \$20 million in legal bills, lobbying efforts, and extra engineering costs on top of the cable's original \$125 million price tag, not to mention lost momentum in its bid to lead the emerging

merchant-transmission market. TransÉnergie lost out to a competitor in a bid to build a second merchant DC power line to Long Island last fall (but it remains in the running to build a link from northern New Jersey to Queens that would connect the New Jersey and New York grids). [Similar political dramas](#)* could keep the merchant-transmission market hobbled for years.

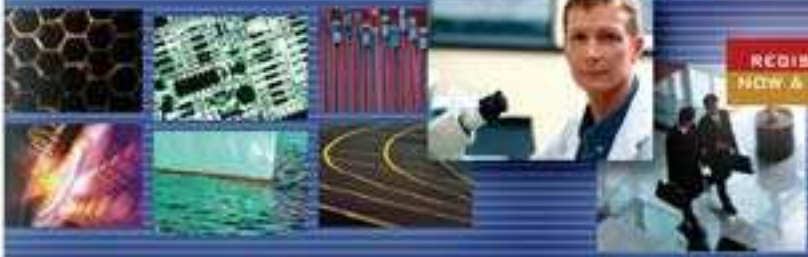
Participants in the Cross Sound Cable saga say that TransÉnergie could have surmounted its political obstacles sooner. Donahue wishes his firm had surveyed the bedrock along the cable route more intensively. He also wishes it had "educated" Connecticut politicians on the cable's benefits early on. (TransÉnergie had brought in United Illuminating partly to help it master the local political landscape, but insiders say the partner did little to help sell the project.) Grilli, a veteran of New York politics, says TransÉnergie also should have responded more aggressively to Blumenthal's high-profile attacks. "TransÉnergie just let him go out there and define the issue. It was extremely difficult to wheel that back."

The larger problem, of course, is the mishmash of state and federal rules that govern power transmission, which leaves entrepreneurs like Donahue vulnerable to political attack. Power-transmission experts like Sally Hunt say the merchant-transmission market won't be stable or profitable until the companies, power authorities, and politicians involved hash out a reasonable process for coordinating regional investments in power transmission. A good place to start, according to Hunt, is with the rules about how transmission services are bought and sold, which must be redesigned to reward the improved reliability that the most sophisticated devices deliver.

These issues are highly technical and not at all sexy. But the alternative to sorting them out—and opening the door for future Cross Sound Cables—could be regular blackouts of historic proportions. Power politics "doesn't make big headlines, but it's really the important issue," says Hunt. "It could really prevent the development of good technology."

PETER FAIRLEY

* WWW.TECHNOLOGYREVIEW.COM What's holding back implementation of better power grid technologies? Industry experts comment. Keyword [cable](#).



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Spalding: An Idea with Bounce

One breakthrough ball design infused a stagnant brand with new vitality.

WHEN DAN TOUHEY, 29, became manager of basketball products for Spalding's sporting-goods division in 1997, his group was doubtful about the prospects of creating a truly breakthrough product. Spalding was a respected brand name, but buyer indifference had been driving basketballs—which Spalding sold in greater numbers than any other company—toward the dreaded status of a commodity.

As soon as he arrived, however, Touhey began looking for new ways to inject excitement into his products. "Consumers are rarely able to verbalize what their real needs and problems are," says Touhey, who had previously worked at Bayer as a product manager for Alka-Seltzer Plus Cold Medicine. "When a moderator in a focus group asked about problems people had with basketballs, the number one answer was probably grip. But once the conversation was steered toward inflation, every hand would shoot up. *Everyone* had a story." Spalding managers had been aware of inflation frustration for years, but little had been done to address the problem.

The idea that changed how Spalding approached inflation hassles occurred on Thanksgiving Day, in 1998. As Touhey watched his father get ready to carve the family turkey, the bird's plastic pop-up thermometer gave him the idea for a miniaturized pump that would reside inside the ball when not in use.

Touhey knew that getting the company



The official maker of the NBA's balls conceived a slam-dunk consumer product.

Spalding (a division of Russell)

Headquarters: Springfield, MA

Founded: 1876

Russell's 2003 net sales: \$1.19 billion

The case: Spalding's Infusion basketball was a risky technology bet in a product category that hadn't seen a hint of real innovation since nets replaced peach baskets in gymnasiums across the country. But the investment unquestionably paid off, boosting sales by tens of millions of dollars and leaving the company with a wholly new approach to innovation.

to invest in his micropump idea was a long shot. "There was a cultural fear of taking a big leap—of becoming involved in a blue-sky project that didn't have a well-defined endgame," says Touhey. Creating a tiny mechanical device appeared to be well beyond the capabilities and resources of Spalding's R&D staff, who had been focused on more routine adaptations such as changing the ball's texture with different "pebbling" patterns. Additionally, Touhey feared that middle management in the company would hesitate to get on board with a risky investment.

But Touhey got lucky. Eddie Binder, an aggressive new executive vice president of marketing who was in his first week on the job when Touhey pitched him the idea, gave it the okay. Binder suggested that Touhey find a contract design firm to develop a quick-and-dirty mockup that would make the consumer benefits of the new design—now called "Infusion"—more tangible for the executives, marketers, and engineers who would have to rally around it.

Then came the real work. The plan was to build a drinking straw-sized pump into the ball itself: insert a fingernail into a small slot in a rubberized disc on the ball's surface, turn 90 degrees, and the pump would pop out. Users would be able to add air at about one pound per square inch of pressure per minute. Compared with creating a new pebbling pattern, the Infusion project was like rocket science. Literally: one resource Touhey's team relied upon was a former NASA engineer in Spalding's golf product division, which controlled brands such as Top-Flite golf balls and Ben Hogan clubs. While basketballs had remained technologically static for decades, the golf engineers were used to employing the latest in materials and computer-aided design and testing technologies to improve their products on a yearly basis. The NASA engineer used software common in aerospace design to solve the Infusion project's most intractable problem: guaranteeing uniform bounces, even around the micropump.

Product quality was of paramount importance. Infusion couldn't be viewed as a gimmick; if it didn't stack up against the best offerings in the market, it couldn't display the valuable "official ball of the

NBA” tagline. Spalding also had to ensure that the new product’s weight, balance, bounce, and durability were identical to those of traditional balls. But after almost two years spent building the world’s first basketball with moving parts, Spalding hit all of its performance targets.

The samples, tooling, consulting fees, materials, testing, and trips to manufacturers in China that went into the project ended up costing Spalding approximately \$1 million, easily twenty times what it typically spent on a new product for the sporting-goods division (such as a ball with a new material or pebbling pattern). But it was worth it; Spalding’s share of the \$140 million basketball market in the United States bounced up from 32 percent just before the launch of Infusion in February 2001 to 64 percent one year later. Chris Burston, a buyer of team sports equipment for San Francisco’s Sports Basement superstores, admits he was initially “really leery of buying a ball with a tiny machine inside. But I don’t think we’ve had any returned—and we have a superlenient return policy. This is just a great product for the father and son who come into the store and want to start playing immediately.”

Infusion’s dramatic success convinced many managers that the golf side of the house wasn’t the only place where investment in innovation could pay dividends. “We had always thought our NBA relationship and official license would be the primary determinant of growth,” says Touhey, “but we began to focus on the mantra that we were going to make technology and new products the lifeblood of our company.” Touhey estimates that, before Infusion, marketing managers at Spalding devoted 10 to 15 percent of their time to new-product development. Post-Infusion, the marketing group spends around 40 percent of its time on new products*, whether on incremental improvements or on more ambitious innovations.

Spalding wasn’t exactly the first firm in the industry to latch onto the idea of building a brand around innovation and cutting-edge performance. Indeed, high-tech materials are the norm in some



Inspired by the pop-up thermometers in Thanksgiving turkeys, the Infusion pump hides inside the ball until needed.

sports. Carbon fibers once found mostly in exotic aerospace applications, for example, are now helping women’s tennis groups everywhere boost their serve speeds into the triple digits. But while other companies found that enthusiasts would gladly pay premiums for even slightly higher performance from their snowboards and sailboats, Spalding knew it would have to look at product functionality in very different ways.

“Purists really focus on the fact that the ball should remain mostly unchanged. But changes in other sports technologies are already altering the ways games are played,” says Touhey. “We looked at what we had done with the Infusion program as a model for the type of innovations that would be welcomed: those that, number one, eliminated some of the annoying aspects of playing the sport and, number two, would maintain or enhance the integrity of the game.”

Touhey points to recreational softball as an area where technology run amok has disrupted the game, providing his company an opportunity to set things right. The popularity of aluminum and even carbon fiber bats had dramatically changed the sport over the last several years, allowing even moderately skilled players to slug home runs. Teams were piling up scores to the tune of 30, 40, and sometimes even 50 runs a game. With all of the marathon games on their fields, league managers found it nearly impossible to adhere to their nightly schedules. Some tried to introduce complex workarounds such as limiting the number of home runs any one

player could hit in a single game, but such measures proved unpopular.

Spalding experimented with different ball designs that could help return slugging power to a manageable level. Ron Laliberty, a veteran of the Infusion project, introduced techniques for developing multilayer golf balls that he had learned from the engineers at Top-Flite. He found that a soft “mantle” layer of thermoplastic elastomer would restrict the flight of poorly hit balls. Marginal players would no longer be rewarded with towering homers just because they bought expensive bats, but players who hit the ball squarely could still reach the fences. Spalding also found that the ball, marketed under the Dudley brand, was less damaging to bats and eliminated most of the stinging vibrations caused by mishits.

Spalding continues to seek out new insights—and not just by watching ballers on the playground or weekend warriors on the diamond. “A colleague clipped an article about Pull-Ups diapers, of all things, that talked about how the diaper holds uncomfortable wetness against the toddler’s skin for five minutes so that the kid seeks out potty training,” says Touhey. “It got us thinking on new tangents. How could touch and feel become a part of learning good techniques for throwing a ball? Maybe new materials could show a thermal handprint on a football, so you could see if you’re throwing with the right grip.”

In May 2003, Spalding’s owners sold the sporting-goods division to Russell, the maker of Russell Athletic outerwear and Bike protective gear. Russell has integrated the basketball-related product lines from two of its other recent acquisitions, backboard makers Huffy Sports and American Athletic, into the Spalding business unit. “Huffy was focused primarily on cost containment before, but it’s amazing what happens when the engineering and product development people are given the opportunity to develop premium, category-changing ‘statement products’ rather than try to save a few bucks on existing offerings,” says Touhey. “Whether you look at Spalding’s role within Russell as an ‘innovation engine’ or just a good example, we think we can spread the mentality and help people act on category-changing innovation ideas quickly.”

JEREMY B. DANN

*** WWW.TECHNOLOGYREVIEW.COM** How can other “low-tech” businesses be reenergized by the use of new technologies? Keyword **spalding**.

Sun Microsystems: Blog Heaven

Hundreds of Sun employees write weblogs about their work. Does all this chatter add up to better business?

MARKETS ARE CONVERSATIONS," announced the famous New Economy screed *The Cluetrain Manifesto*, published in 2000. The manifesto's theme is that the Internet allows many more such conversations—but that they are only valuable if they are conducted in an authentic human voice. "In just a few more years," the manifesto warns, "the current homogenized 'voice' of business—the sound of mission statements and brochures—will seem as contrived and artificial as the language of the 18th-century French court."

Many dot-com nostrums are best forgotten, but the idea that honest, unfiltered conversation between companies and customers might actually be *good* for business lives on—and, in fact, is being embraced by dozens of large firms, from Microsoft to Maytag. To the degree that open conversation does happen, it's happening largely through weblogs, or blogs. In their first incarnation in the late 1990s, blogs were mainly personal online diaries, repositories of their authors' daily experiences, passions, and frustrations. But over the past year or two, a new kind of weblog has emerged: the employee blog. Maintained on company servers and open to the public, these blogs are used by many high-tech workers for debate, free association, and collecting input about projects.

Most companies are still cautious when it comes to communicating with mainstream media outlets; employees are seldom allowed to speak with journalists without media-relations chaperones. But blogs have emerged as an exception, with

more and more companies concluding that the public-relations benefits outweigh the risks. One of those companies is Sun Microsystems, which promotes employee blogging more aggressively than any other technology firm. "Sun's employees are our most passionate evangelists," says Jonathan Schwartz, Sun's president and chief operating officer and the author of a



Cubicle-bound workers have a new way to vent.

Sun Microsystems

Headquarters: Santa Clara, CA

Employees: 32,000

Revenues, Q2 2005*: \$2.84 billion

Revenues, Q2 2004: \$2.89 billion

The case: A growing number of high-tech employees write public blogs at work, about work. That violates almost every traditional precept of corporate communications—but Sun and a few other firms are showing that a few honest blogs can be worth a thousand press releases.

*QUARTER ENDING 12/26/04

company blog read by tens of thousands of visitors every month. "From where I sit, the more our investors and customers know about us, the better."

Sun's Simon Phipps, whose job title is chief technology evangelist, says that researchers and developers can swap more ideas, build better software, and meet customers' needs faster if they are active in online communities, where blogs play the dual role of soap- and suggestion-box. "In a world where you must speak with an authentic voice," says Phipps, "the obvious way is to let the people you most trust—your employees—speak directly to the people you most want to appeal to—your customers." According to Phipps and Schwartz, not only do Sun's blogs show customers that the company is paying attention to their concerns, but they have also become a major channel for communicating with programmers outside the company who write crucial third-party applications that run on Sun's hardware and operating systems.

More than 1,000 of Sun's 32,000 employees blog about their work (most at blogs.sun.com). Schwartz uses his blog to share his unvarnished thoughts about, among other things, Sun's competitors. A January entry, for example, blasted IBM for its reluctance to make software that will run on Sun's latest operating system, Solaris 10, on Intel-compatible hardware platforms. At the other end of the corporate ladder, plenty of rank-and-file programmers air more mundane problems, such as product delays, and invite readers to submit bug reports or suggestions for new features in Sun software.

Companies with top-down management cultures and controls on the flow of information probably aren't ready for the era of employee blogging. Nor is their reluctance likely to hurt them, if they have a locked-in base of customers; don't expect to see employees at Lockheed-Martin blogging about their progress on the latest stealth technology, for example. But consumer-oriented companies that abjure the blogosphere are missing out on opportunities to generate buzz, monitor customer concerns, and—perhaps most importantly—show their human side. As Schwartz puts it, "Any company that feels threatened by blogs probably feels threatened by the Internet." **WADE ROUSH**

Political Networking

Political choices, as much as technological innovation, define the structure of new media

WHEN PEOPLE DISCUSS politics and the media, the topic is usually bias and spin. Radio, TV, and the Internet today are thick with ideological combat, and public opinion about both news and entertainment media is increasingly split along partisan lines.

Politics and the media, however, have a deeper relationship. Since the founding of the United States, government policies have determined what kind of media would develop, under what rules they would operate, and, as a result, how political parties and candidates would compete with each other. In determining the architecture of communications networks, allocating scarce resources such as radio spectrum, and translating constitutional principles into new technological contexts, the federal government has established a crucial part of the framework of American politics.

Beginning in the 1790s, the United States established a postal network that connected its principal cities with its small towns and villages. Congress guaranteed all newspapers postal distribution and afforded them two kinds of subsidies: discount rates to subscribers and a right of free exchange with other newspapers. As a result, American newspapers were not just formally protected from censorship by the First Amendment but also given substantial material aid. The government thereby created the conditions for both a dynamic and decentralized press and a highly competitive electoral politics. Starting with the Jeffersonians in the late 1790s, political parties quickly discovered that creating networks of partisan newspapers was a route to electoral victory. The election of 1800 didn't just mark the first peaceful transfer of power from one party to another; it also signaled the invention of a new means of democratic political insurgency: newspaper coverage.

Historians date the popular use of radio for voice communication to November 2, 1920, when Westinghouse's Pittsburgh station KDKA went on the air to broadcast the results of the presidential election. There couldn't have been a more fitting occasion for the debut of American broadcasting than an election night. Over the following decade, political decisions about the structural arrangements and rules of broadcasting determined what kind of medium radio was going to become.

Under legislation passed in 1927, the Federal Radio Commission (FRC) began awarding licenses to stations—or withholding them. The most basic choices about broadcasting involved the allocation of the spectrum. The FRC could have divided up the spectrum among large numbers of low- and moderate-powered stations. But instead it emphasized high-powered stations and adopted criteria for awarding licenses that favored commercial organizations. Within a short time, CBS and NBC dominated the medium.

Informally, even before 1927, American broadcasters began to work out a set of rules for political access to the airwaves that virtually amounted to a system of private regulation of politics. The key element was a distinction between news (to be covered at the expense of the broadcaster) and advertising (to be paid for by the candidate or party). Subsequently, Congress required stations to “afford equal opportunities” to opposing candidates. An important extension of the equal-opportunities principle came in 1949, when the Federal Communications Commission—which had succeeded the FRC in 1934—adopted the “fairness doctrine.” The doctrine required stations to air controversial news and public-affairs programming and to offer reply time to people who disagreed with their views.

Recent decades have seen radical transformations of the media, and many people tend to see those changes as en-



Paul Starr is professor of sociology at Princeton University and cofounder of the *American Prospect*. He won a Pulitzer Prize in nonfiction in 1984; his most recent book is *The Creation of the Media*.

tirely driven by technology. But legal and political decisions have remained central in determining what kind of media develop. In 1987, the FCC discarded the fairness doctrine, and it no longer uses its authority to promote public-affairs programming. The abandonment of the fairness doctrine also released the broadcast media from requirements for balance and opened the way to the targeting of ideological audiences. In a sense, these developments represent a return to the partisan journalism of 19th-century America. Partisanship was muted in the media through the mid-20th century; now it is far more open, sharp, and often belligerent.

The lesson is as old as the Post Office: the framework we create for communication is a framework for politics. America's early postal system contributed to a highly competitive electoral system. The classic era in broadcasting favored the two major parties at the expense of others but preserved a degree of balance. Now the U.S. media are in the thick of the political battle between conservatives and liberals. No wonder the fight for an edge in the media seems so critical to who wins and who loses in American politics. ■



ELIMINATING EMISSIONS AND

Someone should make hydrogen vehicles and their refueling stations a reality. Only GM could.

Only General Motors has teamed up with Shell to introduce the nation's first hydrogen refueling pump at a retail station. It's the endgame of a multi-faceted strategy GM set in motion years ago to make cleaner cars and trucks powered by hydrogen. Right now, a test fleet of hydrogen-powered GM vehicles

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Technology Review looks at technological projects and problems in selected countries.

What matters *most depends on where you are.*

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"GLOBAL VILLAGE" WAS always an idealistic oxymoron. Politically, culturally, and economically, the differences among nations loom far larger than any differences that might exist among neighborhoods made up of small clutches of homes and shops.

Technology, too, stands as a dividing line. Anyone who travels will quickly notice how amenities that are taken for granted in one's home country are elusive or nonexistent in other lands. Partly, this comes from a disparity in resources. But there are also just different ways of assessing what really matters.

In the following collection of stories, *Technology Review* brings you the view from seven countries. They are a sampling of the world: Northern Hemisphere and Southern, nations developed and developing, with traditions democratic, autocratic, and Communist. In four cases (China, Germany, the Netherlands, and the United States), the writers are editors of *Technology Review* or of one of its foreign-language editions. For reports on technology in the other three countries (South Africa, Chile, and Brazil), we turned to journalists who cover those countries. We asked these writers to report on which

emerging technologies are the most important for their nations' societies and economies, and to explain what makes these technologies uniquely characteristic of their countries.

Each country reveals its own preoccupations, usually born out of its peculiar history and current circumstances. Leave it to the Dutch, for example, to pour computer modeling resources into the management of water and soil—endeavors without which the Netherlands' very existence would be imperiled. The United States has measured the value of R&D projects largely by their potential for adding to the nervous nation's power to fight wars and defend against terrorist attack. In Germany, home of the world's first superhighways and some of its most storied carmakers, it's no surprise to see projects aimed at making driving safer and smarter.

In all, our reporters identified more than two dozen emerging technologies or ideas about innovation as vital to the futures of these seven countries. But even those innovations that most directly address urgent regional needs prove to have application for the entire planet. ■

Brazil

The giant of South America is weaning itself from oil and bringing the Net to the poor.

By Laura Somoggi

BRAZIL'S TWO TOP priorities are to reduce dependence on imported energy sources and to bring digital technologies to the vast majority of the country's 180 million people who cannot now afford them.

In energy, the center of the greatest activity is biodiesel, a fuel made from the oil of seeds such as soybeans, castor beans, and cottonseed. Biodiesel could become an attractive, domestically produced alternative to petroleum-based fuels. Brazil has enacted a law requiring diesel oil sold in the country to be 2 percent biodiesel by 2008 and 5 percent biodiesel by 2013. Because the country has huge amounts of land that is unsuited for food crops but that can easily grow oil seeds, "Brazil can become a global biodiesel power," says Maria das Graças Foster, secretary of oil, gas, and renewable energy at the Ministry of Mines and Energy.

The consequences could be considerable. Brazil now imports 15 percent of the 37 billion liters of diesel it consumes annually. Large-scale use of biodiesel fuels would allow it to all but discontinue those imports and would create jobs in needy farming communities. There are also significant environmental benefits: substituting biodiesel for petroleum-based fuels reduces emissions of unburned hydrocarbons, carbon monoxide, sulfates, sulfur, and other pollutants.

Another alternative fuel that could help Brazil reduce its oil dependence is ethanol from sugarcane. A study conducted by Roberto Giannetti da Fonseca, a specialist in foreign trade, found that Brazil is the largest producer of

fuel ethanol in the world, with an export potential of up to 10 billion liters per year for about \$2 billion in revenue. Because of its extensive use of ethanol fuel, Brazil has developed the flex-fuel car, which features a combustion engine that can burn ethanol, gasoline, or any combination of both. Volkswagen introduced the car in Brazil in March 2003. Last year, sales of new flex-fuel or ethanol vehicles amounted to 26 percent of overall car sales. According to Booz Allen estimates, that fraction could rise to 40 percent within the next two years, and Brazil could begin to export the flex-fuel technology. "Thanks to this technology, Brazil will be dependent on neither oil nor ethanol," says Fernando Reinach, executive director of Votorantim Novos Negócios, the venture capital subsidiary of the Votorantimi Group, a major Brazilian industrial conglomerate.

While reducing energy dependence will help the Brazilian economy in the long run, another technological initiative is starting to have more-immediate consequences. Only about 12 percent of Brazilians own PCs. The last few years have seen a number of projects designed to make computer technology accessible to large numbers of Brazilians for whom it was previously unaffordable. The Committee for Democracy in Information Technology (CDI), for example, collects PCs in good working condition that businesses have discarded as obsolete and ships them to information-technology training centers. More than 900 schools in Brazil and abroad have benefited from this program.

In 2001, a new project was born, one intended to provide Brazilians who don't own PCs with a sort of virtual machine—as long as they have access to a pub-

licly shared computer terminal. The project is called Computador de R\$1.00, or Computers for 1 Real—the equivalent of about 40 cents. That's the price of a recordable CD that stores personal data and settings that customize the appearance of a computer screen. The user simply inserts the disc into the CD drive of a computer at a school, a public library, or even a shopping mall. The system reads the disc and presents a personalized computing environment, complete with application software and access to additional content over the Internet. The system is already in

place in pilot form in community centers and schools in cities such as São Paulo, Brasília, and Campinas; hundreds of Brazilian schools will soon begin offering system discs to their students. Project collaborators include Siemens, T-Systems, Brasil Telecom, Brasília University, publisher Editora Abril, and Brazilian infotech firm Samurai.

One application of information technology in which Brazil is taking a leading role is voting machines. In Brazil's 2000 local elections, for the first time, all 5,559 of its municipal districts offered voters the chance to cast their ballots electronically. Most polling places used a simple, portable electronic voting machine. To

boost confidence in the system's reliability, Brazilian law guarantees that all political parties can examine the machine's software before the election, says Paulo César Bhering Camarão, information technology secretary of the Supreme Electoral Court. A digital signature extracted from the software can then be used to verify that the program used on election day is the same one examined previously.

Laura Somoggi is editor of Harvard Business Review Latin America.

By the Numbers

Genetically modified crops	5 million hectares
Average cost per 20 hours of Internet use	\$27.99
Cable television subscribers per 1,000 people	14
High-tech exports (% of manufactured exports)	19%
Information and communication technology spending per capita	\$205
Internet users per 1,000 people	82
Mobile phones per 1,000 people	201
Prescription drug purchases	\$5 billion
R&D spending (% of GDP)	.8%

SOURCES: INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS, WORLD BANK, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

China

Chinese researchers are pursuing a SARS vaccine—and energy and computing independence.

By Elsie Chan

SOME OF THE world's most polluted cities are in China, so it's no surprise that clean energy sources are one of the country's research-and-development priorities.

The Solar Energy Institute at Shanghai Jiaotong University, for instance, has built a one-story, 245-square-meter prototype house that relies on multiple forms of renewable energy, supplemented with energy from conventional sources. The house's power system includes an array of photovoltaic cells that generates 1,700 watts of electricity under peak sunlight conditions, and three sets of 300-watt wind turbines. The system can generate about 3,000 kilowatt-hours of electrical power each year, mainly for lighting, household electrical appliances, and water pumps.

Outside the house stands a street lamp with its own independent solar-power system. Twenty square meters of solar-energy panels and 2,000-watt terrestrial heat pumps provide heat for both the rooms of the house and the water supply. Twenty people a day can bathe in summer, or 10 in winter, and still leave enough hot water for routine use. The same heat pumps work in reverse during the summer to cool about one-quarter of the house, an area of 60 square meters. Based on the average amount of annual sunlight in Shanghai, the system could provide 10,700 kilowatt-hours of heat per year. The goal is for the house to draw 70 percent of its needed energy from the sun.

A solar-energy collecting tube invented by a professor at Tsinghua University could make solar power more practical. The glass vacuum heat collector has an aluminum nitride coating that absorbs solar energy. Each of the coating's multiple layers absorbs a different wavelength of light, turning it into heat. The collector can capture 50 to 60 percent of incoming solar energy, which can then be used to heat water or air. Tsinghua has applied for more than 30 patents on the device, which is already offered commercially in China, Switzerland, Japan, and Germany.

In another energy efficiency project, the research group for clean-energy automobiles at the College of Automotive Engineering at Shanghai Tongji University is developing what it calls the "Chunhui" (or "Spring Sunlight") series of cars, which have independent electric drives for each of their four wheels. The Chunhui cars are powered by lithium batteries and hydrogen fuel cells; their only emission is water vapor.

Another problem that afflicted China in recent years was the outbreak of severe acute respiratory syndrome, or SARS. Here, too, researchers are making significant strides. In December, the Chinese Academy of Medical Sciences and Chinese biotech company Sinovac successfully completed a first-stage clinical study of a SARS vaccine. Researchers at the academy developed a protein chip to detect antibodies against the SARS virus, established the analytical techniques for the

SARS serum mass-spectrum fingerprint, and developed the enzyme-linked immunosorbent assay (ELISA) test kit for SARS diagnosis, which can be more than 90 percent accurate if used more than 10 days after the first symptoms appear.

China's reputation in electronics is that of a low-cost manufacturer of products designed and developed in other countries. It's starting to shed that reputation, though. Last year, the Chinese Academy of Sciences unveiled the Dawning 4000A, a supercomputer that performs more than 10 trillion operations per second and at the time ranked 10th on the list of the highest-performance computers in the world. The machine is intended to provide information-processing services for research organizations, manufacturers, and commercial enterprises throughout China.

Chinese researchers have also attacked what has been one of the most significant gaps in the country's technology portfolio: the lack of a home-grown computer chip. In 2002, the Chinese Academy of Sciences announced the development of the "Godson" series of CPU chips, marking a new beginning for the Chinese information technology industry. With Godson, the country finally owns its own processors, on which it owes no royalties and which can be tailored to better meet local needs. Finally, after years as a manufacturing colony, China can start to achieve computing independence.

Elsie Chan is editor of Technology Review's China edition.

By the Numbers

Genetically modified crops	3.7 million hectares
Average cost per 20 hours of Internet use	\$10.14
Cable television subscribers per 1,000 people	75
High-tech exports (% of manufactured exports)	23%
Information and communication technology (ICT) spending per capita	\$58
Revenue of top ICT firms	\$30 billion
Employees of top ICT firms	191,600
Internet users per 1,000 people	46
Mobile phones per 1,000 people	161
R&D spending (% of GDP)	.6%

SOURCES: INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS, WORLD BANK, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT



Chile

Biotech innovations improve the country's core industries of mining and salmon fishing.

By Gonzalo Argandoña

HOW CAN A SMALL South American country compete economically with nations that invest 10 to 20 times as much in research and development? Chile's strategy is to search for solutions for local needs that have not been addressed overseas. In particular, universities, private companies, and the government are working together to develop new biotech applications for industries vital to Chile's economy.

Take mining. Chile is the world's largest producer of copper, and copper accounts for about half of the country's exports. But it is becoming more and more difficult to find high-grade deposits that are cheaply and easily mined. The government has therefore encouraged a partnership between the state-owned mining corporation Codelco and Japan's Nippon Mining and Metals. A joint venture between these two organizations, called Biosigma, is developing the use of bacteria to extract copper from ore. This approach, known as biomining, is less expensive and less environmentally destructive than conventional processes. "We are one of the first companies totally specialized in the development and application of genomics for mining," says Ricardo Badilla, CEO of the Santiago-based company.

For years, Chilean copper miners have used microbes to extract copper and other metals from low-grade mineral concentrates. The organism most commonly used is a bacterium called *Acidithiobacillus ferrooxidans*, which breaks the bonds

between copper and sulfur. But researchers at Biosigma isolated a new set of bacteria that work better than this old standby. The company sequenced the bacteria's genomes and applied for patents on some of the genes it found. (Biosigma has not disclosed the identity of the bacteria.) The process looks so promising that this year Biosigma will receive an additional \$16 million from its parent companies to continue operations. Biosigma plans to field-test the new bacteria by year's end.

"We hope to achieve a two- to threefold increase in Codelco copper reserves," says Badilla. Such an expansion would have an impact throughout the global market, because Codelco owns about 20 percent of the world's total copper reserves.

Another successful public-private partnership has delivered a biotech innovation that reaches not into the earth but into the water. The Chilean salmon industry—ranked second only to Norway's—is threatened by a bacterium that grows within salmon liver cells, killing off massive numbers of fish in salmon farms and costing the industry as much as \$150 million a year. Because this microbe—*Piscirickettsia salmonis*—does not cause nearly as much damage in the Northern Hemisphere, Chilean researchers and entrepreneurs had to find a way to combat it on their own.

The work was coordinated by Pablo Valenzuela, the senior research officer at the Millennium Institute of Fundamental and Applied Biology in Santiago. Valenzuela and his team sequenced all the salmon-killing microorganism's genes, which allowed them to identify those genes responsible for the infection.

Those genes were then used as the basis for a set of five vaccines, which were successfully tested at fish farms. The most effective vaccine was licensed to Novartis

Animal Vaccines. Valenzuela estimates the potential market for the vaccine at around \$50 million per year, while annual research costs were only about \$1 million.

The abyss that currently yawns between university researchers and the needs of industry is considered one of the main constraints on innovation in Chile, as well as in other Latin American nations. Valenzuela has proposed a strategy for encouraging biotech development in five industries that are of particular importance to Chile: mining, aquaculture,

forestry, wine, and fruit. "The idea of this plan," Valenzuela explained in a recent paper, "is to position Chilean biotechnology under the umbrella of successful industries, similarly to what happened in the United States with health-related biotechnology organizations initially employed by pharmaceutical companies."

Biotech could also aid Chile's wine industry, which has experienced explosive growth in recent years. Nicolas Beltran, a researcher at the University of Chile in Santiago, has worked with winemakers to develop a system that uses a standard chemical sensor—an "electronic nose"—and an artificial neural network to certify the quality, purity, and origin of wines. The system can be "trained" to distinguish between cabernet sauvignon, merlot, and chardonnay. Beltran is now working to give the system the ability to recognize the valleys where the grapes were cultivated in order to certify their denomination of origin.

Gonzalo Argandoña is a writer and TV producer based in Santiago, Chile.

By the Numbers

Average cost per 20 hours of Internet use	\$21.81
Cable television subscribers per 1,000 people	57.4
High-tech exports (% of manufactured exports)	3.2%
Information and communication technology spending per capita	\$246
Internet users per 1,000 people	238
Mobile phones per 1,000 people	428
R&D spending (% of GDP)	.6%

SOURCE: WORLD BANK

Germany

Germans are working on networked automobiles, safer nuclear plants, and neurotechnology.

By Thomas Vašek

A CENTURY AGO, with its world-leading chemical industry and its cadre of top physicists, Germany was widely considered a technological heavyweight. But it has now fallen behind in many areas of emerging technology. The German biotech industry, for example, started much too late (it hardly existed until the mid-1990s) and is still trying to make up ground. And while German universities are doing excellent research on nanotechnology, many worry that the country will not turn that basic science into products.

Germany's greatest strength is its automobile industry. In the years to come, many emerging technologies, from optical communication links to nanotech materials, will find their way into cars. Technological innovation will be critical to creating the opportunities that will lead German carmakers and their suppliers out of their current trouble. In particular, German carmakers are betting on computer-based assistance systems that could make driving safer and more comfortable.

The basic idea is that a car would map information from a variety of sensors, like cameras and radars, into a digital model of the surrounding traffic conditions. In case of danger, the system would issue a warning to the driver. In more-advanced systems, vehicles could use wireless communications to inform each other in real time about oil puddles, traffic jams, or accidents. BMW is working on wireless networks for cars that will automatically set up connections among vehicles in order to exchange critical sensor information; a car that detects a

slippery stretch of pavement, for instance, could relay that information to other cars on the same road. The goal is to create networks of intercommunicating cars that could someday form a sort of automotive Internet. Researchers at the University of Stuttgart, in collaboration with DaimlerChrysler and other German carmakers, are also designing and testing systems to assist drivers at intersections. Such systems might combine information from traffic lights or signs with onboard-sensor data about other vehicles and their speed or distance in order to get the drivers safely across.

Although they have introduced prototypes of hybrid gasoline-electric vehicles, carmakers in Germany are betting on the longer-term vision of fuel cell cars that consume hydrogen. DaimlerChrysler, for example, has said it will bring such vehicles to the market by 2010. And in what has the makings of a startling turnaround, the demand for hydrogen that would result could help bring about a nuclear renaissance in Germany. In the late 1990s, after massive antinuclear protests, the government coalition of Social Democrats and Greens decided to shut down Germany's nuclear power plants by 2020. The country committed itself instead to developing renewable energy sources such as wind and solar power.

But whether renewable energy sources can ever contribute sufficiently to German energy production is much debated—hence the reemergence of the nuclear option. Developers of so-called third-generation nuclear plants claim that their

technology is much less risky. The European pressurized-water reactor, for instance, developed by Siemens and the French company Framatome, has various safety features—such as double-wall containment—that by limiting the release of radioactivity are supposed to make a catastrophic core meltdown much more manageable. Given the availability of such improved reactor technologies, Germans might possibly change their minds about nuclear energy. Though the coalition now in power remains adamantly opposed to it, the Christian Democratic Party has announced that if it regains power—not an unlikely prospect—it will rethink the country's policy on nuclear energy.

Looking further ahead, German researchers are doing world-class basic science in fields ranging from materials science to biomedicine. German neuroscientists have made important contributions to research in brain implants and in noninvasive brain-machine interfaces. But neurotechnology brings with it tricky ethical dilemmas. One concern is that the findings of brain science will undermine our notion of autonomy and individual responsibility. In wrestling with these issues,

neuroscientists in Germany and elsewhere must reconcile the powers of new technology with the concepts of consciousness and free will. But that's a task that may very well suit the country that gave the world Immanuel Kant.

Thomas Vašek is editor in chief of Technology Review's German edition.

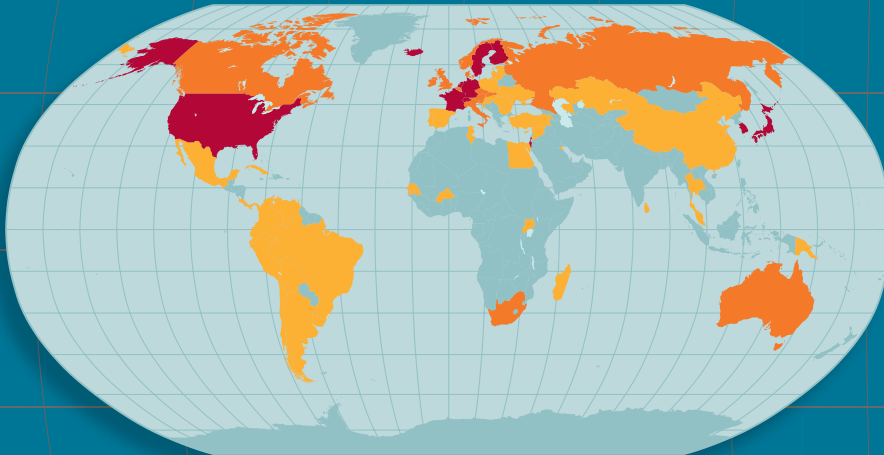
By the Numbers

Average cost per 20 hours of Internet use	\$14.10
Cable television subscribers per 1,000 people	250
High-tech exports (% of manufactured exports)	16.6%
Information and communication technology (ICT) spending per capita	\$1,252
Employees of top ICT firms	751,600
Revenue of top ICT firms	\$153 billion
Internet users per 1,000 people	412
Mobile phones per 1,000 people	727
Prescription drug purchases	\$25 billion
R&D spending (% of GDP)	2.5%

SOURCES: IMS HEALTH, WORLD BANK, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Measuring Global Technology

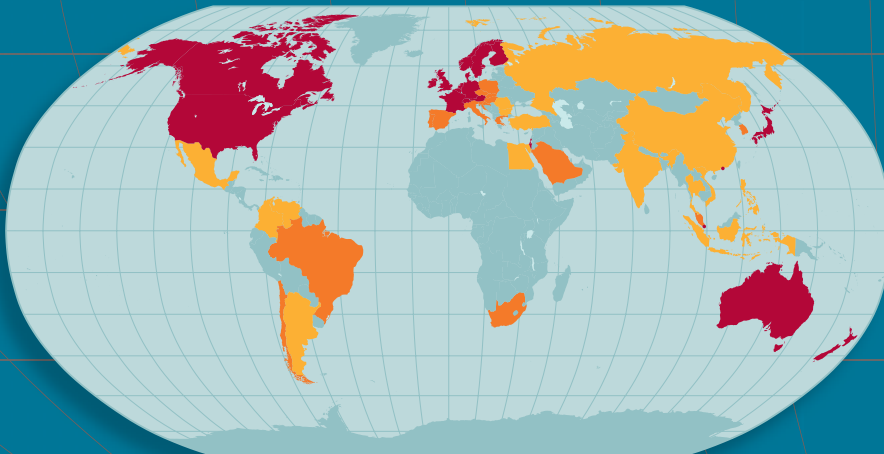
Economically advanced European and North American countries may leap to mind as global technology leaders. By and large, that's the case. These countries tend to fare particularly well on such measures as Internet usage, technology spending per person, and cost of Internet access. Economically developing countries are relatively well represented when it comes to significant mobile-phone and Internet use as well as, increasingly, the production of genetically modified crops.



R&D as a percentage of GDP

TOP FIVE COUNTRIES

1. Israel
2. Sweden
3. Finland
4. Japan
5. Iceland



Information and communication technology spending per capita

TOP FIVE COUNTRIES

1. United States
2. Switzerland
3. Denmark
4. Sweden
5. Norway



Producers of genetically modified crops

TOP FIVE COUNTRIES

1. United States
2. Argentina
3. Canada
4. Brazil
5. China

Mobile-phone use per 1,000 people

TOP FIVE COUNTRIES*

1. Luxembourg
2. Israel
3. Italy
4. Iceland
5. Sweden

Internet use per 1,000 people

TOP FIVE COUNTRIES

1. Sweden
2. South Korea
3. United States
4. Canada
5. Denmark

Cost of Internet access

MOST EXPENSIVE COUNTRIES

1. Central African Republic
2. Sudan
3. Haiti
4. Gabon
5. Republic of the Congo

Scale: High Mid Low

DATA IS FOR 2004 UNLESS OTHERWISE NOTED. COST PER 20 HOURS OF INTERNET USE: DATA IS FOR 2003; HIGH IS >\$50, MID IS \$30-\$50, LOW IS <\$30. R&D SPENDING AS A PERCENTAGE OF GDP: DATA IS FOR 2000-2002; HIGH IS >2 PERCENT, MID IS 1-2 PERCENT, LOW IS <1 PERCENT. INFORMATION AND COMMUNICATION TECHNOLOGY SPENDING PER CAPITA: DATA IS FOR 2002, EXCEPT FOR ICELAND, WHICH IS FOR 2001; HIGH IS >\$1,000, MID IS \$200-\$1,000, LOW IS <\$200. MOBILE-PHONE USE PER 1,000 PEOPLE: DATA IS FOR 2000-2002; HIGH IS >500, MID IS 100-500, LOW IS <100. INTERNET USE PER 1,000 PEOPLE: DATA IS FOR 2000-2002; HIGH IS >150, MID IS 15-150, LOW IS <15. SOURCES: INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS, WORLD BANK, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

*IF CONSTRUED AS A SEPARATE ENTITY, HONG KONG WOULD RANK THIRD ON THIS LIST.

South Africa

Open-source software and speech technology could help this multicultural country pull itself into the information technology big leagues.

By Janet Paterson and Pamela Weaver

SOUTH AFRICA HAS a language problem. Its 46 million people speak 11 official tongues. Enter the Human Language Technology (HLT) unit at the Council for Scientific and Industrial Research (CSIR) in Pretoria—one of the largest R&D, technology, and innovation institutions in Africa.

HLT researchers are developing innovative ways to give more people, from diverse backgrounds, access to knowledge. “In dealing with South African needs, we have to take into account the level of literacy of users, their technical sophistication, and cultural factors,” says Marelie Davel, the computer scientist who coheads the HLT research group.

One of the HLT unit’s biggest success stories is a highly efficient system for the creation of pronunciation dictionaries. Davel explains that the system has been tested on a number of South African languages, including isiZulu, Setswana, Afrikaans, and Sepedi. Researchers have also developed a speech synthesis system for isiZulu, which is the first language of

more South Africans—24 percent—than any other. The system, which is now being tested, enables people with only a reading knowledge of isiZulu to communicate orally with native speakers.

South Africa’s other major area of innovation involves communication of another sort: the collaborative process that is the heart of the open-source-software movement. More than 80 percent of the country’s six-billion-rand (about \$1 billion) annual spending on software and licensing goes to foreign companies, according to the Shuttleworth Foundation’s Go Open Source campaign. This reliance on proprietary hardware and software hinders the development of South Africans’ information technology skills and closes off opportunities for economic growth.

Open-source software brings with it the tools that are essential to South Africa’s capacity to produce original software and create new local markets and opportunities. It also expands access to computing among a previously disadvantaged populace, since open-source operating systems often run smoothly on older machines that would crawl under the strain of the latest version of Windows. Without open-source products, many African children would have little opportunity to use computers, because proprietary systems are simply beyond the means of most schools.

One organization leading South Africa’s open-source renaissance is Go Open Source, funded by billionaire South African businessman and space tourist Mark Shuttleworth. Go Open Source has distributed free CDs containing open-source software and a local Linux distribution called Ubuntu (a Bantu word

meaning “humanity to others”). The South African company Canonical offers support for Ubuntu Linux as well as a translation utility aimed at addressing the problem of accessibility. (Try persuading a big proprietary developer that it’s worth its while to develop software for speakers of Sotho or Xhosa.)

South Africa’s first entirely home-grown Linux distribution has come out of the Impi Linux project. Named after the warriors of the Zulu tribe, Impi Linux 2 was built from scratch by a team of Linux user groups with the backing of local software firm Cubit and guidance from Ross Addis, chair of the Gauteng Linux Users Group. “Developers from other countries either don’t know or don’t care about South African needs,” Addis says. He cites the rapid adaptation (about two weeks) of Impi Linux 2 so that it included support for local firm Sentech’s broadband “My Wireless” service.

The Free and Open Source Software

Foundation for Africa estimates Africa’s IT industry to be worth \$25 billion. There is a growing sense that ceding such wealth to Western companies squanders an opportunity to tap the country’s indigenous software-development talent. Open source offers Africa the opportunity to become a continent of developers rather than consumers of Western IT products. It could offer ordinary South Africans unrestricted access to an array of applications that will enable them to build up their own businesses, educate their children, and develop the IT skills that will let South Africa run on the technology road with the rest of the world.

By the Numbers

Genetically modified crops	500,000 hectares
Average cost per 20 hours of Internet use	\$33.33
High-tech exports (% of manufactured exports)	3.2%
Information and communication technology (ICT) spending per capita	\$225
Internet users per 1,000 people	68
Mobile phones per 1,000 people	304

SOURCES: INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRICULTURE, BIOTECH APPLICATIONS, WORLD BANK

Janet Paterson is editor of the South African business strategy magazine Intelligence. Pamela Weaver is editor of the technology magazine NetPlus.

The Netherlands

A country that engineered itself into existence is tapping into its centuries-old expertise in handling water.

By Erwin van den Brink

DECEMBER'S DEADLY TSUNAMI in the Indian Ocean drove home how vulnerable low coastal areas are to the forces of nature. In the Netherlands, which carved itself out of the ocean centuries ago—and a quarter of whose land mass is below sea level, while two-thirds is vulnerable to flooding—the mastery of coastal waters remains the object of much technological innovation.

The Dutch acquired their hydraulic expertise partly in response to disaster. In 1953, a number of sea dikes in the southwestern part of the country gave way under a tidal surge. The disaster, which killed about 1,800 people, spurred one of the largest hydraulic projects in the country's history: the Delta Works. Almost all of the inlets and estuaries in the southwestern part of the country were closed off by a system of dams and storm surge barriers. One of the two main arteries remaining open—the estuary near Rotterdam—was fitted with the most massive movable storm surge barrier ever built. Known as the Maeslant Barrier, it has an automated control system that closes its giant doors based on real-time weather information, which can indicate the approach of a spring tide. The system's software borrows from a branch of mathematics called formal methods; its performance is continually monitored, and improvements are made as knowledge of weather behavior progresses.

Were Holland's dikes, dams, and pumping stations ever to fail again as they did in 1953, a densely populated, 150-by-150-kilometer area would suffer from a catastrophic flood. Bas Jonkman, a civil engineer with the Dutch Ministry of Transport, Public Works, and Water Man-

agement, and Nathalie Asselman, a researcher with Delft Hydraulics, recently simulated a dike breach near the Dutch town of Capelle aan den IJssel. According to their simulation, in the worst-case scenario, the water in the village could rise five or six meters in a matter of hours, killing about 72,000 people.

To help prevent such tragedies, the Netherlands has computerized most every aspect of sea defense management. Institutions such as Delft University of Technology, UNESCO-IHE Institute for Water Education, WL/Delft Hydraulics, and the technology development consultancy TNO run computer models that simulate the reaction of water and sediments to human interference. Those simulations are used to estimate the effects of such megaprojects as building an airport on an artificial island in the North Sea or creating thousands of acres of new land near the coast—indeed, for almost any civil-engineering project.

Weather and climate systems, like shifting sediments and the currents of rivers and seas, are impossible to describe accurately using linear models. Research by Dutch mathematicians on nonlinear systems has produced computer models of these phenomena that are of vital importance to the country's survival. Thanks to these models, the pumping stations that keep the Dutch lowlands from flooding can anticipate prolonged rain spells, and mechanical storm-surge barriers can be closed in time when massive storms approach.

Dutch engineering has focused on not just controlling the flow of water but also keeping it clean. The drinking-water chain in the Netherlands is a fully closed

system: sewage water is treated so that it can be safely discharged into surface water. The purification of drinking water has recently come to rely on new, environmentally friendly techniques: using ultramembranes and ultraviolet light to kill bacteria. Ultramembranes, with pores so fine that they can physically screen individual cells, have gained wide adoption over the past five to 10 years. Ultraviolet technology developed by Dutch engineering companies such as DHV is commonly used in the "after-disinfection" stage of water treatment, as a second level of defense. However, the Dutch water company PWN has begun employing UV light during the entire disinfection process. PWN's technique uses a photochemical process to create powerful oxidizers, which break down organic compounds so that they can be consumed by aerobic bacteria that reside in active carbon filters. According to Peer Kamp, head of innovation at PWN, the next challenge will be the removal of all traces of pharmaceutical drugs from water.

Dairy and meat products, along with flowers, make up 20 percent of Dutch exports. And the agricultural and food-processing industries are becoming more entwined with the pharmaceutical industry. A few years ago, for example, the Dutch-British firm Unilever

launched the product line Becel pro.activ (marketed in other countries under the name Flora), which helps people control their cholesterol. Ultimately, such "functional foods" could help to prevent heart disease and perhaps diabetes. Dutch technology, here as in its massive feats of environmental engineering, aims to keep people safe.

Erwin van den Brink is editor of Technology Review's Netherlands edition.

By the Numbers

Average cost per 20 hours of Internet use	\$24.10
Cable television subscribers per 1,000 people	401
High-tech exports (% of manufactured exports)	28%
Information and communication technology (ICT) spending per capita	\$1,505
Employees of top ICT firms	216,900
Revenue of top ICT firms	\$42 billion
Internet users per 1,000 people	412
Mobile phones per 1,000 people	745
R&D spending (% of GDP)	2.0%
SOURCES: WORLD BANK, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT	



United States

Spooked by terrorist attacks, the U.S. is devoting much of its R&D to defense and homeland security. By Jason Pontin

AMERICAN TECHNOLOGY—JUST like its foreign policy, domestic politics, and popular culture—has been swept up into what President George W. Bush calls “the global war on terror.” The U.S. R&D establishment has narrowed its interests in the years since September 11, 2001, concentrating its resources on technologies that provide security: weapons systems, defenses against biological weapons, biometrics, network security. The U.S. government’s research-and-development budget is now bluntly militaristic. In fiscal year 2005, federal R&D spending rose 4.8 percent to \$132.2 billion, but 80 percent of that increase went to defense research. And most of *that* increase is committed to the development of new weaponry, like the ballistic-missile defense system. In all, the

government will spend 57 percent of its R&D budget for 2005, or a record \$75 billion, on defense-related projects. President Bush’s proposed 2006 budget, now being debated in Congress, would

introduce cuts to many civilian programs but spend an additional \$600 million on defense research.

The Department of Homeland Security is particularly flush: its 2005 R&D budget increased 20 percent from the previous year. In 2005, the new Homeland Security Advanced Research Projects Agency (HSARPA) received \$300 million. But the administration plans to give the agency an extraordinary \$1 billion in 2006. HSARPA is concentrating on late-stage technologies that the government could procure in only three to five years. But according to Lita Nelsen, director of MIT’s Technology Licensing Office, such a near-term focus is “robbing from the future, because that’s not basic, curiosity-driven research.”

The data support Nelsen’s contention. The National Science Foundation had its 2005 R&D budget cut by .3 percent in 2005, and the National Institutes of Health (NIH) enjoyed a budget increase of only 1.8 percent. It will get worse: the government plans to increase NIH’s budget by only .7 percent in 2006.

The U.S. government’s preoccupation with security would be less important if the private sector were investing in basic research. It is not: for years, corporate R&D has stressed return on investment through the timely creation of new products. And U.S. venture capitalists have responded to government and corporate demand by disproportionately funding security-related startups. Since 2000, according to Venture Economics, communications funding has dropped 83 percent, and software investment is down 77 percent; but during the same period,

defense investment fell only 58 percent. Fields like robotics, nanotechnology, and genomic medicine are underfunded. Venture capitalists have a “lemminglike instinct when it comes to investment themes,” admits Bill Kaiser, a general partner at Greylock Partners in Waltham, MA.

The U.S. obsession with security may yet yield wondrous technologies; it has happened before. “Uncle Sam might be investing in the next Internet,” Nelsen says. Ken Morse, managing director of the MIT Entrepreneurship Center, insists that security investment “is a good thing.” After all, he says, “thoughtful government funding years ago has spawned cool companies.”

Recent funding of defense and security has already produced technologies for civilian use. Lincoln Laboratory, a research institution at MIT that works mainly with the Department of Defense, has created several interesting “dual use” technologies. Using luminescent proteins produced by a jellyfish gene, for instance, the lab has developed a biosensor that glows in the presence of bio-warfare agents. In 2003, the device, known as Canary (which

stands for “cellular analysis and notification of antigen risks and yields”), was licensed to Innovative Biosensors in College Park, MD. The company believes it may be useful for medical diagnosis, too.

But technologists worried about the future of innovation in the United States may share Nelsen’s gloomy assessment. “Everyone is frightened that some Iraqi is going to put anthrax in our hamburger meat,” driving up spending on defense and security, she says. “But in the meantime, what’s happening to the other technologies?”

Jason Pontin is editor in chief of Technology Review.

By the Numbers

Genetically modified crops	47.6 million hectares
Average cost per 20 hours of Internet use	\$14.95
Cable television subscribers per 1,000 people	255
High-tech exports (% of manufactured exports)	32%
Information and communication technology (ICT) spending per capita	\$2,358
Employees of top ICT firms	3.5 million
Revenue of top ICT firms	\$938 billion
Internet users per 1,000 people	551
Mobile phones per 1,000 people	488
Prescription drug purchases	\$345 billion
R&D spending (% of GDP)	2.6%
SOURCES: INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS, IMS HEALTH, WORLD BANK, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT	

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Online shopping didn't develop as its promoters promised. But by bringing new Web technologies into their stores, retailers are changing shopping in ways few anticipated.

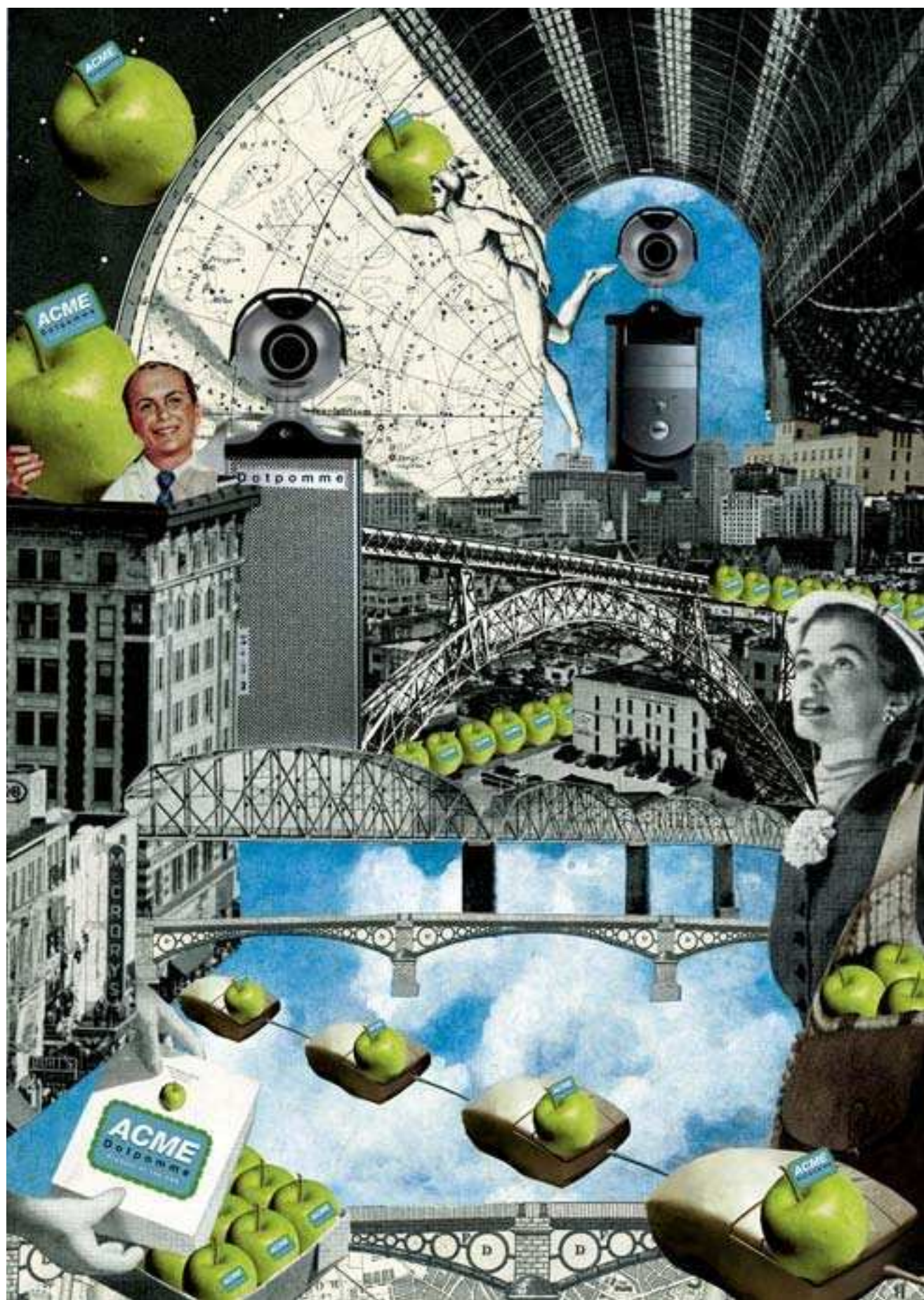
By Robert Buderl

ILLUSTRATION BY NICOLA ACKLAND-SNOW

E-Commerce Gets Smarter

VISIT THE REI flagship store in downtown Seattle for the first time, and you'll stop in wonder. On the grounds surrounding the store, which spans an entire block of otherwise ordinary urban landscape, a hiking trail and mountain bike test track meander around a waterfall and brook. Inside the main entrance, a 20-meter-tall rock climbing pinnacle looms over shoppers. And on the shelves and display stands that sprawl across two gigantic floors of retail space are stacks of backpacks, hiking boots, canoes, kayaks, tents, jackets, and just about every other outdoor clothing item or accessory you can name. You feel younger, stronger, and more adventurous just *being* here. ¶ On any given day, somewhere between backpacks and winter socks, a man and a woman who are

soon to be married will be roaming the aisles. One will be carrying a handheld device about the size of a cell phone and pointing it at something he or she likes. The device is an infrared reader: push a button, and a laser beam reads the bar code of the targeted item. When the reader is synched with a specially equipped cash register, the item is added, instantly, to the couple's online REI gift registry. Eric Thorson, operations manager at the store, smiles when he thinks about the couples he's seen. "We have one scanner per couple, and we'll have the future wife run upstairs to women's clothing, and [the groom] wants to be downstairs in the climbing department picking out an ice axe," he says. "It's almost like it becomes the ultimate shopping adventure for the two of



them rather than thinking about what would be a practical wedding gift.” The scanner can record some 300 items, but, Thorson notes, “I’ve seen scanners come back that we have to upload and send back out because they filled the memory.”

It may seem strange, but those couples traversing the aisles—downloading, uploading, and somehow fusing in-store interactions with website maintenance—are the future of e-commerce. Other retailers provide similar scanners, but the resulting Web registries must be manually updated. REI is one of those making e-commerce far more interactive—automating updates and using the Web to make registries available to all its stores and business channels.

The benefits for REI customers are real. Any customer can view the registry, either at an in-store kiosk or online. And if an item is purchased—whether through mail order, over the phone, on the Internet, or in any of REI’s 77 stores—the list is instantly updated at all those locations. Customers can buy online but decide to pick up or return at a store. Discounts are the same in all locations, and every item offered on the Web can be ordered through the store or catalogue, and vice versa.

The business jargon for this model of integrated retail sales is “multichanneling”—that is, fusing digital services with in-store, mail-order, and telephone sales, and with any other retail channels. The digerati have called it “clicks and mortar” since the Internet boom of the 1990s. No matter the term, it is now the driving force in retail. For while the Internet works fine for some types of goods—such as books, computer products, and music—many shoppers don’t want to purchase and pay shipping costs for things like canoes, cars, clothes, and entertainment systems without trying them out, trying them on, touching them, or maybe even talking to a knowledgeable salesperson.

New technologies and ideas are allowing retailers to remove the wall between online shopping and in-store shopping, and to make the gathering of customer data both easier and more valuable. Advanced data-mining and Web analytics techniques now examine not just what you bought online but what you viewed, helping retailers design promotions that will entice you to shop online *and* in stores.

These enticements will themselves arrive over multiple channels—through magazines, regular mail, e-mail, the Web, and wireless transmissions to your car or shopping cart. By looking at just a few of a customer’s purchases, a retailer will even be able to predict how much she’ll spend over her lifetime, and adjust the deals and promotions it offers her accordingly.

The ultimate goal is more-customized, personal service. The best retailers have always striven to provide the most-tailored service possible; however, as more and more retailers expand nationally and even internationally, building close relationships with customers is increasingly difficult. “Retailers can’t do that now because they have millions of customers all over the country,” says Dan Hopping, senior consulting manager for IBM’s Retail Store Solutions Division. “So they use technology to make the connection.”

REI Speedwagon

The sales figures for 2004 are in, and e-commerce is on a roll. Online retail spending soared 26 percent last year, to \$66.5 billion, according to business analysis and advisory firm Jupiter Research. That’s 4 percent of total retail spending—compared with nothing about 10 years ago, and with 3 percent in 2003. By 2009, Jupiter predicts, online spending will reach 6 percent of total retail sales.

But that’s just a small part of the e-commerce story. Last year, another \$355 billion in retail sales took place in physical stores *after* consumers had done their homework online. Overall, says Jupiter, for every \$1 consumers spend online, they spend \$6 dollars offline as a result of research conducted on the Internet.

That’s why retailers want to find better ways to exploit the many ways in which people shop, so that customers research and buy from *them*, not their competitors. “It’s a leaders-and-laggards thing,” says Jonathan Reynolds, director of the Oxford Institute of Retail Management at the University of Oxford. “In nearly every country, you’ve got one or two particular companies that are ahead of the game. The message to the laggards is, you better have a good story or else risk losing market share to those firms who are setting the multichannel standard.”

Few companies are better at such integration than REI. Case in point: in June 2003, the company began offering customers the option of ordering products online and picking them up at stores. The concept grew out of an examination of the in-store Web kiosks that REI began using in 1998. The kiosks had proven a good source of product information to supplement what the sales staff could provide, but customers also used the kiosks to place orders when stores didn’t have items they wanted—which meant they would have to pay shipping costs for the goods they had just come into the stores to buy. Says Joan Broughton, REI’s vice president of multichannel programs, “You don’t want people to feel penalized by the fact the store doesn’t happen to carry that item they’re looking for.”

Providing in-store pickup seemed a good way to minimize that frustration, and also to serve other online customers leery about paying to have, say, canoes delivered to their doors. Still, REI trod cautiously. The program wasn’t advertised, so shoppers found out about it only when it came time for checkout on the REI website: in-store pickup was offered alongside shipping options. REI had 66 stores at the time. On the first day, 60 of those stores received pickup orders. Today, such orders are trucked out of REI’s central warehouse on distinctively colored pallets and are packaged in special dot-com wrapping, so that when a shipment arrives at a store, employees can easily tell what should be held for customer pickup.

When an item comes in, its bar code is scanned to register its arrival. An e-mail notification is sent to the buyer. During a normal week, 600 products ordered online come into REI’s flagship store. Over the holidays, says Thorson, the number is four times that. That represents \$2.2 million, about 4 percent of annual store sales. But online customers who choose to pick up their orders in stores spend an average of \$30 more once inside.

The principle behind REI’s approach—understand what people want and use technology to make shopping easier—is recognized by retailers worldwide. Change, however, has come slowly. Many companies set up online stores in the mid-to late 1990s, often building proprietary systems that were not integrated with

other parts of their operations. Later, harmonizing operations seemed expensive and difficult. It's only since the economy has improved that some retail executives have been investing more heavily in integrating their sales channels.

In the labs and strategy rooms where the next generation of e-commerce is being shaped, firms are looking at new ways to use technology to become more profitable. Here's a look at what's in the works.

Check Out the Supermarket

Five years ago, online shopping was something you did from a home or office PC. You didn't expect to find the future of e-commerce in the aisles of your neighborhood supermarket. Indeed, dot-com upstarts such as Netgrocer, Peapod, and Webvan—all of which delivered goods ordered online to people's doors—aimed to put a serious hurt on their physical-store counterparts, not to work with them.

you log onto the website through a home computer or PDA, it lists your favorite or recently purchased items—whether you bought them in a store or online.

In this manner, Tesco has amassed a mountain of data about its customers, which it uses in various ways. Regular-mail statements to all loyalty card customers include quasi-personalized coupons tailored to their buying habits. Some coupons might provide discounts on products a customer has recently purchased. Others offer discounts enticing customers to try new items Tesco thinks they might like. In addition, Tesco puts out five editions of a quarterly hard-copy “magazine,” each of them tailored to a broad audience segment: students; young adults without dependents; young families with children; people age 40 to 60; and those over 60. Finally, the retailer offers a number of further segmentations, or clubs—World of Wine, Baby and Toddler, and so on—that customers choose to join, and

things the shopper buys most frequently, whether he buys them in the store or has them delivered to his house by Peapod—which, in a neat post-bubble twist, Stop and Shop's parent company now owns. The device creates a map of the store and displays a suggested route. Infrared beacons on the ceiling track the cart's location, so the device can automatically alert the customer if any of his favorite items are on sale in the aisle he is currently browsing. The interface also lets the shopper wirelessly order cold cuts from the deli; an alert sounds when they are ready. Finally, an attached imaging scanner lets the shopper scan items as he puts them in the cart; as the cart fills, a running total is displayed. When it comes time for checkout, the cashier scans the shopper's loyalty card, and all of the items in the cart are listed on the register screen. This saves time for both the shopper and the cashier.

Stop and Shop is expanding the program to 20 more stores in Massachusetts

Five years ago, online shopping was something you did from a PC. You didn't expect to find the future of e-commerce in the aisles of your neighborhood supermarket.

Now, a different approach to supermarket e-commerce is emerging. The most successful retailer in the United Kingdom is the Tesco supermarket chain. An estimated one of every eight pounds spent in Britain on retail, whether in stores or online, goes to Tesco, says Reynolds.

In contrast with companies such as the now defunct Webvan, which supplied online orders from central warehouses, Tesco services Internet orders in its stores. This arrangement is extremely profitable, because it builds on spare capacity within the store network, and orders are filled by store staff during quiet periods. Whether customers purchase online or in stores, the data about what they buy is linked to Tesco's loyalty card, so the company “knows who you are irrespective of the channel you come in on,” Reynolds says. If

which enable even more precise delivery of promotional offers.

A farther-out approach—bringing e-commerce to the supermarket shopping cart—is being tested by Stop and Shop of Quincy, MA, which operates 350 supermarkets in the Northeast. Dubbed Shopping Buddy, the technology consists of a wireless computer and data management system developed by IBM in partnership with the supermarket chain and software maker Cuesol, also of Quincy.

The paperback-book-sized device, introduced early last year at three stores near Boston, is installed in shopping cart handles. To use it, a shopper scans in his loyalty card; a simple graphical interface then appears, displaying such features as sale items and a customer favorites list. On the favorites list are the names of the

and Connecticut, says marketing director Peg Merzbacher. The company is also working on new features—one of which will allow customers to create online shopping lists that will automatically appear on the Shopping Buddy when they arrive at a store. Merzbacher says integrating physical-store presence with Peapod helps both businesses by adding convenience and building loyalty. “Hardly anybody converts to total online shopping,” she says. “They go back and forth, [and] when you get people to use both channels, they spend more.” IBM is also pushing the limits of the Shopping Buddy technology, hoping to better tailor advertisements and promotions, and generally improve the shopping experience. Rakesh Mohan, senior manager of IBM Research's Industry Solutions group, says

there's no reason such a device can't suggest a wine to go with a meal or provide dietary guidance by reporting an item's fat or carbohydrate content. It could even sound a warning if a product that a shopper scanned contained ingredients to which he or she was allergic.

This technology could do for in-store advertising what Google did for online advertising. As search technology has improved, Web-based advertising has evolved to include paid contextual advertisements linked to search terms. If, for instance, you use Google to search for digital cameras, paid advertisements from camera makers will probably appear on the right-hand side of the Google page. Similarly, Mohan says, when a shopper is in a supermarket's laundry detergent section, that's the time for detergent ads to appear on the shopping cart screen. "It's really bringing the Google-type activities into the physical environment," says Mohan.

But is that something we really want? Mohan thinks it is. He argues that these new ads will not feel intrusive, because they will be directly related to what the customer is doing at any given moment. What's more, they have the potential to be far more effective than online ads, because they can be tailored to the person's buying history. And best of all, Mohan adds, they simply appear on-screen without the shopper's ever having to click a mouse. Nor is their application limited to supermarkets; IBM believes such services will be attractive to any retailer.

Gleanings

IBM's Industry Solutions group building in Hawthorne, NY, where Mohan works, houses a big customer demonstration area showcasing new concepts and technologies, many of them aimed at e-commerce. A telematics demo shows how directions, traffic alerts, and promotions can be sent over the Internet to cars, based on their Global Positioning System location. And all around are systems for payment and authentication—from a cryptographic chip for wireless transactions to conversational biometrics, which perform voiceprint analysis while asking questions only authorized users should be able to answer.

The e-commerce technologies pursued here, and at other labs worldwide, cover an

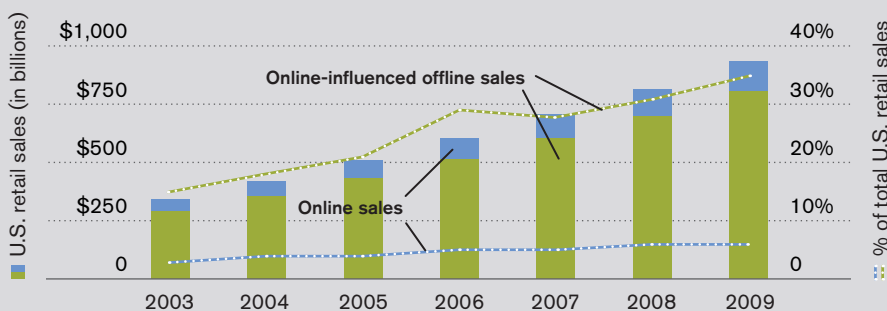
ever expanding range of areas. However, underlying virtually all the personalization and customization efforts are Web analytics and data mining. "We are paying close attention to the tendency of shoppers to visit our online store and then, within a week or so, come in and buy at our retail stores," says REI's Broughton. "We want to get better at providing our online customers whatever they need—product information, store locations, articles about the activities they'd like to enjoy—so that they shop our retail stores as well."

Even when customers don't hand retailers detailed information about themselves, a lot can be gleaned from what they do online. For instance, geolocation and

data-mining company Digital Envoy of Norcross, GA, tracks two billion Internet addresses a day, culling demographic data that advertisers and retailers love. Working like a search engine that studies the Web's infrastructure rather than its content, the firm's system can track an Internet transaction backward from a website to the network node at which it originated in order to answer two questions: what city is the user in, and how fast is her Internet connection? From that information, the system can make a good guess about what business the user is in. Digital Envoy can also identify a person's local area code, time zone, and zip code—and determine what language she speaks.

Web of Influence

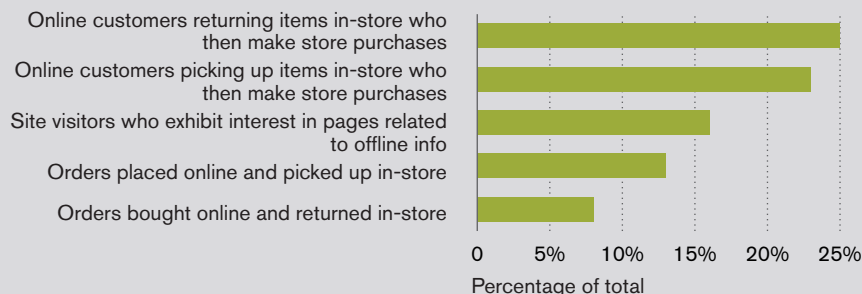
For every one dollar U.S. consumers spend online, another five or six are going to offline purchases that are influenced by online research.



DATA FOR 2005 AND LATER ARE PROJECTIONS. SOURCE: JUPITER RESEARCH

Switching Channels

Multichannel retailers are successfully using their online offerings to increase their in-store sales.



SOURCES: SHOP.ORG AND FORRESTER RESEARCH

The hunger for such information is growing fast, in large part because of e-commerce, notes Digital Envoy cofounder Sanjay Parekh. For one thing, the information improves fraud detection. If a buyer claims to be in Florida, but his Internet address shows he's in Wisconsin, that's a tip-off that something is amiss. Even more to the point, Parekh notes, if a retailer knows that a customer is in New York, not Palm Springs, it might display a different style of clothes on its home page—or dispatch a coupon good at a store in Manhattan. But the biggest force driving data mining is the push to provide better context for the paid keyword ads linked to search terms. Online marketing and advertising service provider DoubleClick, for instance, uses Digital Envoy's technology to help companies create ads that are location specific. The goal, says Parekh: "Drive to a sale much quicker. That's what everything is about."

IBM researchers tackle many of the same issues, though differently. One of the company's projects involves recording a customer's mouse clicks and tracking what was viewed—a red blouse, say. From that data, it's possible to get a good idea of a visitor's feelings about price, color, and size preferences—even his or her gender. If the shopper makes a second visit, the retailer might offer a discount on an item already examined, or something similar. Every purchase gives the store more information about its customer.

Such efforts, of course, raise privacy concerns. In 2001, Big Blue founded the IBM Privacy Management Council, a coalition of privacy and security leaders from health care, finance, retail, and government that seeks to find ways—through technology, standards setting, and business practices—to get ahead of looming privacy issues. A big push is related to database management—so that when you enter personal information like your name, income, and tastes in lingerie into a company database, it is stored in such a way that none of the company's employees can put all the pieces together and trace them to you. Instead, customers are profiled in the aggregate and grouped into broader categories that allow retailers to tailor (and even personalize) offers to people as members of a class but not as specific individuals. Privacy concerns are at the top of the

list for retailers, says Hopping, of IBM's Retail Store Solutions Division, "because if privacy blows up, that's the kiss of death for a retailer."

Retailers must also make the gathering of information about shoppers worthwhile to the shoppers themselves. "To get the customer to opt in, the retailer's going to have to give them something," says Hopping. That can be a discount, he says, but often it is something else—special parking or other services, or a piece of technology like Shopping Buddy that makes shopping easier.

One of the most intriguing areas of research involves figuring out which customers are worth the trouble of wooing in the first place. In its Haifa, Israel, research lab, IBM is designing advanced statistical and machine-learning models that will differentiate customers according to their *future* value.

Researcher Amit Fisher developed one such model by studying a year's worth of activity at one of Israel's leading e-auction sites. From such factors as the number, frequency, and value of their transactions, Fisher was able to classify Internet users into different categories—along the lines of bargain hunter, repeater, one-timer, defector, valuable customer—and assign an economic value to each category. The model then sought to predict from just a few visits where a new user was likely to end up a year or more down the road. "We compared the customer ranking that was generated by our model to the true ranking of the customer according to their purchases," says Fisher. In trials involving groups of more than 1,000 users, he notes, the model correlated almost perfectly with actual data collected from the auction site. Programs that seek to assess a customer's lifetime value are not new; however, IBM says that Fisher's model, which is being developed for commercial use through several of IBM's businesses, is the first to make an accurate assessment of a customer's future value based on just a few visits. What's more, such a model is "domain adjustable," Fisher says. It could be used in banking to determine whether to issue a loan or a credit card. Or it could be employed by retailers to target promotions to potential best customers and give priority to those customers during times of peak demand.

Fisher's model works with minimal personal data and takes into account only a few variables. But for retailers bent on amassing much more complete data about their customers—and then using that information to "maximize" lifetime customer value through highly targeted ads and promotions—the data-mining challenge is far trickier, says Edwin Pednault, a staff researcher in IBM's data analytics research group. "Now I want to take much more information into account," says Pednault—who has been working on a model that would do just that.

Instead of looking at effects of marketing campaigns separately, as traditional data mining has done, Pednault's model examines the patterns of a customer's activity, such as the types of products she likes, how she responds to promotions, and her price sensitivity. When a company has that kind of information about its customers, says Pednault, it can begin to ask, "How are my actions motivating them to change from one [buying] state to another?" In studies of one major department store chain, IBM showed that using Pednault's model to predict the effects of snail mail marketing—alerting customers about sales, store events, and new items from their favorite product lines or styles—resulted in a 7 to 8 percent increase in store revenues.

Self-Control

Some of what customers want can be deduced from their activity alone, but when a store can get people to willingly tell it what they are seeking, its returns can be even better. "You can do it passively, but if you have to buy in, that gives extra value," says Pednault.

That's a key point. In the end, says Oxford's Reynolds, whether companies successfully adapt to the changing face of e-commerce will depend on how well they employ new technologies to go beyond personalization to customization, which means letting their clients shape their own profiles and classifications. "Personalization is what companies do to us," Reynolds explains. "Customization is what *we* want to do." ■

Robert Buderer is editor at large of Technology Review.

Race and Medicine

Population genomics is expanding our knowledge of human diversity. What role should race have in drug development?

By David Rotman

PHOTO ILLUSTRATION BY JOE ZEFF

THE ROUGHLY FIVE million Americans who suffer from heart failure, a chronic and deadly disease, could be part of a radical change in the practice of medicine later this year. Cardiologists across the country will likely begin to prescribe a new, and by most accounts highly promising, drug based on an unusual criterion: whether the patient is black or white—or, to be more precise, whether the person identifies him- or herself as an African American.

Sometime by midyear, the U.S. Food and Drug Administration will decide whether to approve BiDil, a heart failure medicine developed by NitroMed, a small pharmaceutical company in Lexington, MA. Experts say that the drug, if approved, will be the first pharmaceutical targeted exclusively at a specific racial group. While physicians often prescribe medicines differently for white and black patients, the new pill could mark a change in how drugs are clinically tested, reviewed by the FDA, and marketed. And its arrival has set off a heated debate among physicians, geneticists, and social scientists over the biological justification for and social ramifications of so-called race-based medicines—and over how drug developers should handle information about genetic variations in the world's different populations.

At the core of the controversy is a disagreement over whether lumping people into a few broad racial categories has any medical value as a shortcut to more-detailed

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430 MAIN ST, BOSTON, MASS.

DR. Robert A. Johnson

PATIENT Louise Smith

RACE **African-American**

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REFILLS 2

genetic analysis. The debate is particularly urgent because biomedical researchers have begun to identify subtle genetic differences among population groups and are finding preliminary but provocative clues as to why populations often react differently to drugs. Most notably, the International HapMap Project, a consortium of leading genomic researchers, is cataloguing genetic variations by examining the frequency with which certain blocks of DNA occur in different groups around the world (see *"Genes, Medicine, and the New Race Debate,"* June 2003, p. 40). One goal of the HapMap project and related research is to give physicians and drugmakers the tools needed to more accurately predict how different patients will respond to drugs. But fully fleshing out the genomic variations among population groups—and relating them to differences in drug responses—will take years.

Enter NitroMed and BiDil, a pill that, literally, reduces group differences in drug response to black and white. Some argue that it is a form of high-tech racial marketing done by a pharmaceutical industry eager to sell to well-defined groups of consumers. Others, including many physicians, counter that BiDil and other potential race-specific drugs represent a shortcut, albeit a crude one, to using genetic variation to more effectively and safely prescribe medicines. According to this argument, considering the race of a patient is simply a commonsense approach until using more-detailed genomic information becomes practical.

"There are extraordinary opportunities in the tailoring of medicines. It is plainly the future," says M. Gregg Bloche, a physician and law professor at Georgetown University. But using race as a shortcut to that future, he says, "presents all sorts of risks."

The problem, say critics of BiDil, is that while genetic patterns are related to a population's shared ancestries and geographic histories, what are conventionally called races are socially constructed categories that have little basis in biology or genetics. Marketing BiDil only to black patients "is a bad idea," says Charles Rotimi, an epidemiologist and acting director of the National Human Genome Center at Howard University in Washington, DC. The problem, he says, "is in us-

ing a social label that we know is not directly related to genetics" to categorize responses to a drug. That practice, says Rotimi, ignores the complexities and subtleties of population genomics, conflating genetics and race.

Making the debate over BiDil even more contentious is the convincing evidence that the drug is, for many heart failure patients, a lifesaver. Of the five million Americans suffering from heart failure, about 725,000 are African American. And there is evidence that, as a group, African Americans tend not to respond as well to some conventional heart failure drugs, such as angiotensin-converting enzyme (ACE) inhibitors. By nearly all accounts, BiDil could help a significant portion of these African-American patients.

Indeed, NitroMed's clinical trial of BiDil in African Americans—a 1,050-patient study called A-HeFT—was halted last year because results indicated that the drug was helping patients dramatically, and experts considered it unethical to continue denying the benefits of the drug to those trial participants receiving placebos. While the patients in the study were already taking a number of conventional heart failure medicines—some as many as a dozen—adding BiDil to that mix decreased their mortality rate by 43 percent. "When a drug reduces the risk of death by that much," says Clyde Yancy, a cardiologist at the University of Texas Southwestern Medical Center at Dallas and an A-HeFT investigator, "it gets the attention of the medical community. It's a significant opportunity for treating an important disease."

"A Different Disease"

The drug that became known as BiDil didn't start out as a racially targeted medicine. The story of how it came to be the center of the debate on race-based medicines is long and convoluted. It is also a story that, in some ways, reflects the frustration of trying to find more-effective treatments for heart failure, a disease that has reached epidemic proportions: with around 500,000 new cases diagnosed every year, it is the only major form of cardiovascular disease on the rise, and annual death rates have more than doubled since 1979. While the pharmaceutical industry

has developed a series of new drugs for the disease over the last decade or so, less than 50 percent of patients survive more than five years.

Within the field of heart failure medicine, Jay Cohn, the developer of BiDil and inventor on a patent for its use in treating heart failure in African Americans, is a towering figure. A professor of cardiology at the University of Minnesota and director of its Rasmussen Center for Cardiovascular Disease Prevention, Cohn was a founder of the Heart Failure Society of America and has participated in a number of the field's landmark clinical trials of new treatments.

In the 1970s, Cohn was a young, ambitious cardiologist looking for some way to offer hope to his heart failure patients. At the time, there were no drugs that could significantly change the course of heart failure, he recalls. Patients were given digitalis, a 200-year-old medicine used to strengthen the contractions of the heart, and diuretics to alleviate the buildup of fluids, but neither of these drugs averted the fate of the patients. "You got worse and you died," says Cohn.

To change that grim prognosis, Cohn and his colleagues began testing intravenous medications to relax patients' arteries, believing that opening up the arteries would reduce the work the heart had to do. By 1980, Cohn and his partners had come up with an oral treatment that combined a pair of compounds, one that dilated blood vessels and another that boosted levels of nitric oxide, which is thought to be a natural vasodilator in the body. The cardiologists then began a 640-patient study at more than a dozen U.S. Veterans Administration hospitals around the country to evaluate the effects of the vasodilator therapy on those suffering from heart failure.

The results of the V.A. studies showed that patients appeared to gain some slight benefit from the drugs in terms of reduced mortality, prompting various cardiologists' groups, including the American Heart Association, to begin recommending that the combination be given to those who did not respond well to other heart failure treatments. A second trial at the V.A. hospitals was completed in 1991. This time the test compared the two-drug treatment developed by Cohn and his col-

leagues to the ACE inhibitor enalapril, a newly developed type of vasodilator.

In 1996, Medco Research, a small North Carolina drug firm that had licensed rights to the medicine from Cohn, tried to gain FDA approval for the drug combination, which by then had been packaged as a single pill called BiDil. The FDA advisory panel, however, rejected the application for the heart failure medicine, citing insignificant evidence of its efficacy.

It was soon after FDA rejection that BiDil was reborn as a race-specific drug. In 1999, Cohn and several colleagues went

failure in African Americans. Still, acknowledges Cohn, why BiDil works better in blacks than in whites is something of a mystery. “I don’t pretend to understand all the factors,” he says. “And I don’t suggest it’s a uniform difference. But on average, responses appear to be different.”

One possibility is that the effectiveness of BiDil depends on the etiology of the disease—why patients suffer heart failure in the first place. The disease can be caused by various factors, including previous heart attacks or a history of hypertension. And, suspect some experts, BiDil

“heart failure is a different disease in blacks. It’s different in how it presents itself.” Blacks, he points out, suffer from heart failure at a younger age, and they do not respond as well to hospitalization and treatments. BiDil works in part by addressing deficiencies of nitric oxide, which many African Americans show a reduced ability to utilize, says Yancy.

But if, in fact, BiDil works best for those who develop heart failure because of hypertension, it also could benefit thousands of non-African Americans. And clearly the potential deficiencies of nitric

Can medical decisions be based on racial classifications that most scientists say have little genetic basis?

back to the V.A. studies and reanalyzed the data. “To our surprise, blacks dramatically benefited compared to whites,” says Cohn. While Cohn says he suspects BiDil “will work for everyone,” the numbers showed that in whites, on average, the benefit of the drug was marginal—so small that it was statistically insignificant in such a limited sample. But in blacks, the drug combination reduced mortality by 47 percent in the first V.A. study (a finding similar to A-HeFT’s later 43 percent improvement); in the second set of trials done at the V.A. Hospitals, whites responded better to enalapril than to BiDil, but many black patients responded poorly to the ACE inhibitor. For those patients, BiDil appeared to be an effective alternative.

In retrospect, says Cohn, the results shouldn’t have been surprising. At around that time, he points out, other studies suggested ACE inhibitors were less effective in African Americans than in whites, and there was evidence that black and white patients responded differently to drugs for hypertension, the leading cause of heart

works best for those patients, whether white or black, who have developed heart failure through hypertension.

If true, that conjecture would help explain the difference, on average, between white and black responses to BiDil. African Americans suffer from high rates of hypertension, and over 50 percent of blacks with heart failure are thought to have it due to histories of high blood pressure. In contrast, most whites, roughly 70 percent, get heart failure due to heart attacks or chronic heart disease. The reason for the high rate of hypertension in blacks remains uncertain. Some studies point to environmental factors, while others seem to implicate specific genetic variants. Muddling the situation even further, according to Yancy, there is some evidence that genetic factors make hypertension more damaging to tissues in black patients than in whites, so that it is, in effect, a more “malignant” condition in African Americans than in whites.

Whatever the underlying reasons, for cardiologists treating patients, says Yancy,

oxide found in some heart failure patients are not strictly limited to blacks. Yancy, for one, says he is “absolutely confident” that BiDil will work for patients other than African Americans. Indeed, says Cohn, ideally BiDil would be given to all those heart failure patients in whom physicians could “identify nitric oxide deficiencies. Unfortunately, there is no simple test.” So for now, race remains the admittedly imperfect screen for those patients.

Shoehorning Diversity

There, for many critics, lies the rub. Is it medically justifiable for physicians to translate the average responses of broad racial groups into clinical decisions affecting the lives of individual patients? Even more fundamentally, ask critics, how can medical decisions be based on a set of racial classifications that most scientists say have little genetic basis?

Federal guidelines used by the FDA to evaluate clinical trials acknowledge at least five distinct racial categories: Ameri-

can Indian or Alaska Native, Asian, black or African American, Native Hawaiian or other Pacific Islander, and white.

While each of these groups might have its own social and cultural heritage, and even ancestral lineage, there is little evidence of any genetic patterns that would neatly define them as discrete entities, and hence as distinct races. The conventional categories might serve a purpose for social, economic, and political reasons, but most geneticists question whether they have any biological justification. Even the few rare diseases popularly thought to predominate among particular races seldom adhere to conventional categories. For example, sickle-cell anemia, considered by many to be a “black disease,” occurs throughout the Mediterranean, as well as in Africa; parts

while the groups tend to share the same set of variants for a particular SNP block—typically there are a handful of versions of each block, and those versions are found in all groups—the relative frequency of a given version varies among populations.

At the same time that genomic researchers are trying to understand these group differences, journals are filled with studies attempting to relate medical conditions to genetic variants common among particular groups. For example, in a study in the *American Journal of Epidemiology*, researchers reported that black women were more likely than white women to have several genes linked to heightened inflammatory response (see “*Inflammatory Genes*,” March 2005, p. 79).

Particularly relevant to the prediction of drug response is the finding that groups

But basing drug prescriptions on population genetics is still in its early days—and the way to do it remains controversial. The wrong approach, says Howard’s Rotimi, is to shoehorn complex data on genomic patterns into conventional racial categories. Rotimi argues that race is a very imprecise proxy for drug responsiveness. In the case of BiDil, he says, what’s missing is the identification of any relevant genetics that would justify its exclusive use in blacks.

Indeed, even as BiDil heads toward commercialization as a pill likely to be marketed solely to African Americans, there is near consensus among experts that it would also save the lives of countless other heart patients. How to more accurately determine which patients the drug will help is the real issue, according to

Even backers of BiDil agree they are using race as a crude shortcut to identify whom will benefit from the drug.

of Greece have extremely high rates, while black South Africans do not carry the genetic traits causing the illness.

But while largely scorning conventional racial categories, population geneticists and researchers equipped with new genotyping tools are increasingly identifying patterns of genetic variants, particularly single-nucleotide polymorphisms (SNPs), that are prevalent among specific populations. Researchers have found that SNPs, variations of a single nucleotide at a particular spot on a chromosome, tend to occur in blocks called haplotypes. The HapMap project is documenting the relative frequencies of particular blocks in several different populations, including Han Chinese, Yoruba in Nigeria, Japanese, and Americans with north- or west-European ancestry. The project is finding that

can have different frequencies of some genetic variants associated with the body’s key metabolizing enzymes, which affect how drugs are broken down in the body. In fact, says David Goldstein, a human geneticist and director of Duke University’s Center for Population Genomics and Pharmacogenetics, of the 42 genetic variants that have been consistently shown to be tied to drug responses, two-thirds have different frequencies in people with European and African ancestries. “The naïve interpretation,” says Goldstein, “is that these variations would lead to average differences in the relevant drug response in the two communities.” While he adds that such a conclusion is too simplistic, he says the variations “do suggest” that genetics could play a role in determining how well drugs work in various groups.

many experts. NitroMed says it is looking for markers, both genetic and otherwise, that could be used to identify non-African American patients whom BiDil would help. But finding such markers will likely take time and money.

“If the clinical results [of the A-HeFT study] are really convincing, it probably should be approved,” says Goldstein. “But the larger question is what should be required by the FDA.” Goldstein says the agency needs to mandate a comprehensive analysis that will identify the specific types of patients who will benefit from BiDil. “It’s not sensible for FDA to rely on the goodwill of companies. It needs to be proactive.” Goldstein says the fact that African Americans are “spectacularly heterogeneous” means BiDil will work only for a certain fraction of them, cutting Ni-

troMed's potential base of customers. And pinpointing patients in an ethnically diverse population who would also benefit from BiDil will be expensive. "It's too much to think companies will willingly spend money that is not in their commercial interest," says Goldstein.

The terms of an FDA approval of BiDil would also be critical, says Goldstein. "If FDA says it works in blacks and not in whites, it is entirely incorrect. It needs to make clear that blacks are not a distinct genetic entity." Resorting to race, he says, "is never a precise guide" to determining who will benefit from a drug. "If you don't have other information, you might be prepared to use race as an interim measure, but you shouldn't treat it as the end of the story."

These kinds of concerns point up the ambiguous role that race plays in modern medicine. Even backers of BiDil agree that they are using race only as a crude way to identify whom will benefit from the drug. "Race is an extremely poor proxy for genetics," says Yancy. It is critical, he says, "to continue to try and identify the phenotypes that respond best to BiDil and not stop at the level of race. Race-based medicine is a step backwards." At the same time, says Yancy, "It's a long-standing observation that due to complex reasons, both biological and social, health outcomes are divided along the line of race. We have an obligation to patients to analyze why this difference exists." Apparent racial differences in drug responses among groups, he suggests, can present valuable opportunities for biomedical researchers to better understand factors and mechanisms underlying diseases and drug response. "Using race is simply a convenient placeholder," says Yancy. "You need to see what it represents."

"Evildoers"

For many, the main motivation to better understand the factors behind ethnic differences is the troubling health disparities among groups in this country. Many of those disparities are likely due to varying access to health care and to other economic factors. But most existing medicines were tested in clinical trials in which most of the participants were white; if there are genetic differences in how various ethnic populations respond to drugs, they could

be widening the gap in health outcomes.

Esteban Gonzalez Burchard has a quick and affable way of speaking that seems to suddenly slow and turn serious when he explains the subject of his research: why Hispanic populations suffer such dramatically different rates of asthma and respond so differently to asthma drugs. In the United States, Puerto Ricans have a higher rate of asthma than any other ethnic group and tend to respond poorly to albuterol, the leading asthma drug, while Mexican Americans have a low rate of the disease and are effectively treated with medications. It's a perplexing epidemiology riddle as well as a public-health puzzle that affects thousands of lives. Says Burchard, "When a Puerto Rican kid takes albuterol, he is just not getting the same bang for his buck as any other kid."

Like many other areas of genomic research, Burchard's work is at an early stage, and the challenges he faces point up the difficulty of determining the role that ethnic differences play in diseases. Hispanics are extremely diverse culturally and socially; genetically, they have varying mixtures of African, European, and Native American ancestry. But by teasing out the relative contribution of each ancestral group in a particular population (Mexicans, for example, tend to have far smaller genetic inheritance from African ancestors than Puerto Ricans do), Burchard attempts to zero in on specific genetic factors.

Most recently, Burchard, a physician and assistant professor of medicine and biopharmaceutical sciences at the University of California, San Francisco, identified specific genetic variants that seem to be associated with a lesser response to albuterol in Puerto Ricans; in Mexicans, the same variant seemed to have no connection to albuterol. While such a finding might seem ambiguous and inconclusive, it's suggestive to Burchard that some still unidentified factor is behind the ethnic difference. And Burchard says that that is just the point: he might not have yet found the smoking gun, but "I can smell the smoke."

The opportunities created by looking at ethnic differences in medicine are "far bigger than BiDil," says Burchard. Health disparities among racial groups are invaluable clues to untangling underlying genetic and environmental factors that

could make it possible to design safer and far more effective drugs. And it is essential that those clues be followed, says Burchard. "We do see racial differences between populations and shouldn't just close our eyes," he says. "Unfortunately, race is a politically charged topic, and there will be evildoers. But the fear should not outweigh the benefit of looking."

Whether BiDil, with its complicated history and decades-long evolution into a race-specific drug, is the right way to begin making sense of race, medicine, and genetics is debated. Jonathan Kahn, a law professor at Hamline University in Saint Paul, MN, who has written extensively about the history of BiDil and the legal issues surrounding it, maintains that the reasons that the drug is being marketed to African Americans have far more to do with business and patent issues than medical ones. And yet, says Kahn, if the FDA approves the drug exclusively for blacks, it "lends credence to the misguided idea that race is somehow genetic."

Indeed, much of the controversy over BiDil is really about the message that the drug's approval will send to the general public. No one claims that the drug will work only for African Americans; nor does anyone pretend to have identified specific genetic factors exclusive to black patients that account for the drug's effectiveness. Like racial categories themselves, the group of patients whom BiDil will benefit remains ambiguous. But here the disagreement starts: is it worthwhile to use race as a crude, stopgap approximation, or is giving the pill only to black patients a dangerous shortcut to genetic profiling that many in the public will, intentionally or otherwise, misconstrue?

There is no easy answer to the question of how to best balance medical expediency with social consequences. But the real danger of BiDil as a race-based medicine could be in its potential to turn the public's understanding of complex genomic research on differing drug response and disease susceptibility among populations into a simple black-and-white issue. ■

David Rotman is executive editor of Technology Review. He wrote "Genes, Medicine, and the New Race Debate" for the June 2003 issue of the magazine.

Demo

Online at CentCom

Nerve center for the Iraq War, U.S. Central Command headquarters, at MacDill Air Force Base in Tampa, FL, is more wired than ever. Five classified networks link commanders, intelligence agencies, and coalition partners in Iraq, Afghanistan, and other sites across the Middle East and East Africa, the “central” region under CentCom’s jurisdiction. And the demand for ultra-secure bandwidth keeps surging.

By David Talbot
Photographs by Sean Hemmerle





MR. TOLSON	MR. DELOACH	MR. MOHR
MR. BAKER	MR. CASPER	MR. CALLAHAN
MR. CONRAD	MR. FELT	MR. GALE
MR. RUCKELSHAUS	MR. TEGART	MR. WICK

10:04 15:04 20:04 22:04 23:04
ENPAC LOCAL DMT CAIRO DQNA





PREVIOUS PAGES: Commanders fill CentCom's main conference room for a classified video teleconference meeting with Army, Navy, Air Force, Marines, and Special Operations officials in the field. (The left-hand screen shows Navy commanders in Manama, Bahrain.) Eager to see faces and body language of far-flung subordinates, U.S. generals are enthusiastic adopters of these video links. "We'll put it anywhere in the world they want it," says Maj. Damon Stern, who helps maintain the networks. "You'll see systems like this out in the middle of nowhere."

THESE PAGES: Raw information from the field arrives here, the Joint Information Operations Center. Workstations are manned by 46 "watch officers" responsible for everything from drone aircraft pictures to weather reports. (Dummy images were displayed during the photo session.) Journalists sometimes report things first, so CentCom monitors news programs, too. Internet connections and military satellites form the networks' secure backbone, but much equipment and operating software is commercial, on the belief this ensures easier adoption.



ABOVE: Engineers monitor the health of classified networks from the Theater Communications Command Cell. With 250,000 U.S. service members in the Middle East theater—and because demand for data links keeps swelling—this facility is triple the size of the one it replaced last year.

RIGHT: A nimbler fight against an insurgency is possible when networks “multiply ways of moving information up and down the chain of command,” says Brig. Gen. Jeffrey Foley, the “CIO” of CentCom, who directs the network operations. But keeping those networks humming “is about people.”



Engineers and Political Power

Some have it, some don't

IN THE UNITED STATES, engineers don't rule. According to a *Congressional Quarterly* survey of the 109th Congress, there are just four engineers in the House and one in the Senate. When the engineering specialties in the 2004–2005 Statistical Abstract of the United States are combined, there are 2.12 million engineers in the U.S. versus 952,000 lawyers and 819,000 doctors; yet 10 physicians now sit in the House and two in the Senate, and *CQ* lists 160 representatives and 58 senators with legal backgrounds.

One explanation for those discrepancies is that rapid technological change makes it hard for engineers to return from political office to professional life. In a 1992 interview with *Technology Review*, John H. Sununu, President George H. W. Bush's chief of staff, acknowledged that as a consulting mechanical engineer, he was lagging ten years behind the field. Physicians, however, face equally great problems keeping up with the latest research, and by entering public service, they often forgo even greater potential income.

Another theory is that engineers are self-selected for social distance. Sylvia Kraemer is an intellectual historian who became a senior NASA official and interviewed 51 colleagues for her insightful study *NASA Engineers and the Age of Apollo*. She found that lab engineers and those promoted into management endorsed the reputation of awkwardness. A manager declared that most engineers "wouldn't recognize an emotion if it hit them in the face." One rocket engineer flatly acknowledged, "I related to things."

This is an old American stereotype. In *The Engineers and the Price System*, the maverick economist Thorstein Veblen, championing what was later called technocracy, wrote that the public considered engineers a "somewhat fantastic brother-

hood of overspecialized cranks, not to be trusted out of sight except under the restraining hand of safe and sane businessmen." He added, "Nor are the technicians themselves in the habit of taking a greatly different view of their own case."

But in many other cultures, especially in Eastern Europe, Asia, and the Middle East, engineers have been in the thick of power. They've been prominent in Marxist movements, such as the brief Hungarian Communist revolution of 1919. They became influential enough in the early Soviet Union that Stalin directed one of his first purges against them. Later, scientists and engineers were put to work in the gulags' special research prisons, the *sharashkas*. After Stalin's death, engineering degrees became desirable credentials for the politically ambitious. As the historian Kendall Bailes wrote in 1974, "What lawyers and businessmen are in the American political system—the major professional groups from which most politicians and policymakers are recruited—men with engineering backgrounds have become to a large extent in the Soviet Union."

In 2004, almost all two dozen members of China's ruling Politburo had engineering degrees, including all nine members of the Politburo's Standing Committee. In the Middle East, prominent engineers fill the political spectrum, from former president Süleyman Demirel of Turkey to the members of the Society of Muslim Engineers, pillars of the ayatollahs' Iran, to the late secular nationalist Yasser Arafat. In many countries, engineering appeals to the civic minded. On the other hand, disaffected young men recruited in European engineering schools were prominent among the September 11 hijackers. As R. Scott Appleby and Martin E. Marty observe in *Foreign Affairs*, "fundamentalists tend to read scriptures [as] engineers read blueprints—as a prosaic set of instructions and specifications." Civil engineer Osama bin Laden surely did.

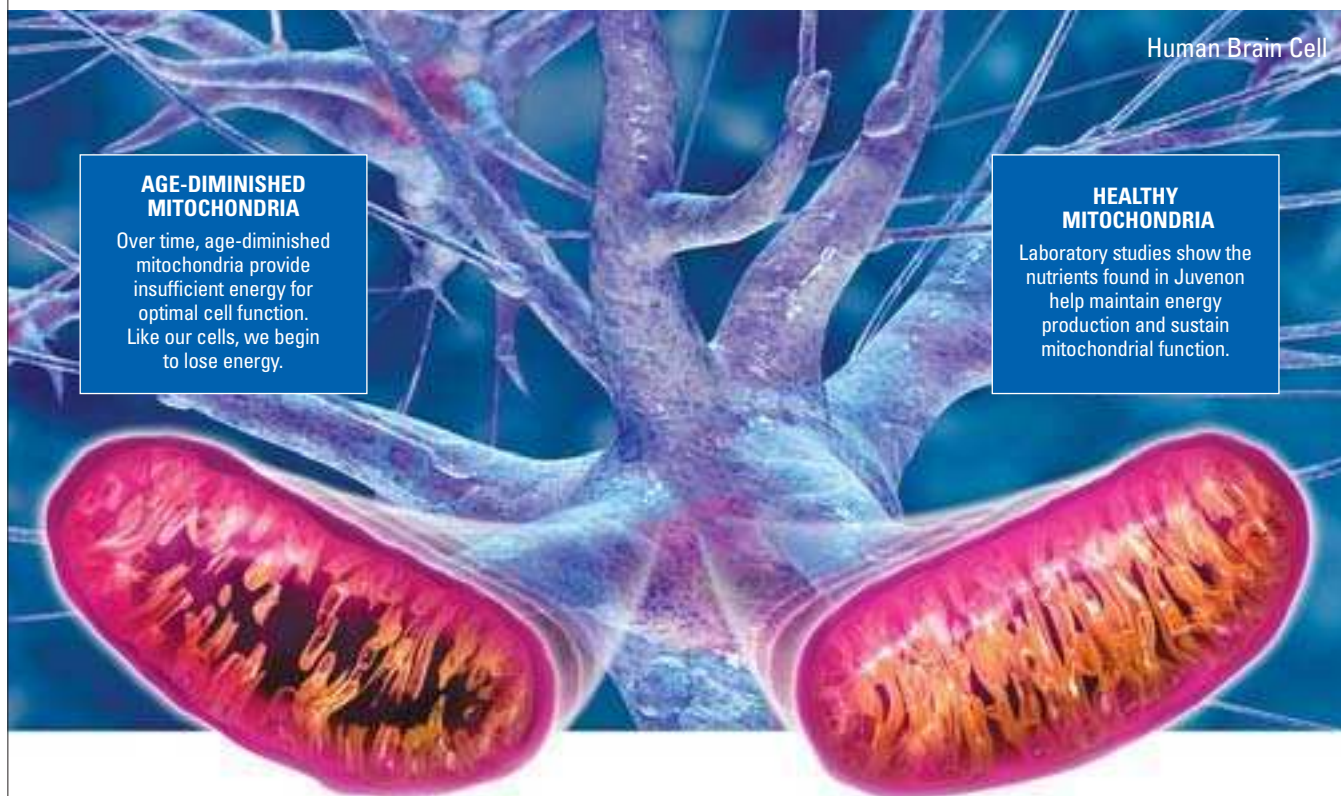
Globally, then, the unpolitical Anglo-American nerd is the exception. The argument that gained credence in 19th-century France and was echoed in other regimes is that a state must be guided by a scientific and technological elite. Two forces kept that notion from taking hold in the United States. The first was American suspicion of central government. The second was industry's appetite for engineers; at the turn of the 20th century, U.S. companies fearing manpower shortages resisted attempts to make elite postgraduate degrees the norm for engineers, as they were becoming for lawyers, doctors, and executives. So engineers in this country continue to design and implement everything but our laws. ■



Nuclear engineer Jimmy Carter, so alone

DENNIS COOK/AP

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Wild Profits

The Arctic refuge may soon be in the hands of Big Oil. Will it drill clean?

BY BRYANT URSTADT

CENTRAL TO THE case for allowing exploration and drilling in the Arctic National Wildlife Refuge (ANWR) is the argument that new technologies will allow industry to get the oil out with minimal damage to the landscape and the wildlife. It is likely that this line of reasoning will be unfurled once again this year, when Republican representatives and senators are expected to pick up their battering ram and renew the charge at the gates of what has become the prize possession of the environmental lobby. The last assault, in March 2003, lost in the Senate, with 52 senators voting to delete from a larger bill a provision that could have opened the refuge for drilling.

The Arctic National Wildlife Refuge is that 79,000-square-kilometer slice of pristine wilderness or barren wasteland, depending upon whom one asks, east of Prudhoe Bay on the North Slope, the largest operating oil field in North America. This is a frozen land so out of the way that it attracts a mere 2,500 tourists a year. By comparison, tiny Sachuest Point National Wildlife Refuge in Rhode Island sees upwards of 65,000. Most of those who do visit ANWR come in the summer and head not for the plain, where the oil is, but 25 to 80 kilometers inland, where the mountains and the grizzlies are.

Temperatures range from 4 °C in the summer to well below –20 °C every day during the winter, with nary a wink of sun in

Drill Kit

Arctic Petroleum Development: Implications of Advances in Technology

By Terry R. Twyman

Congressional Research Service, 2001

December. The section of the refuge under dispute comprises 6,000 square kilometers of the coastal plain, and its fate has awaited a decision by Congress since it was set aside for further study in 1980. It is likely to hold four to twelve billion barrels of recoverable oil, which, though it may not feed the engines of America for even a year, is still a considerable amount. As one government report puts it so well, “The refuge is an area rich in fauna, flora, and commercial oil potential.”

Leading the charge again will be Senator Pete Domenici of New Mexico, chairman of the Senate Committee on Energy and Natural Resources, who intends to add revenue from drilling leases, perhaps in the neighborhood of a couple billion, to the 2006 budget resolution. Drilling in the refuge isn’t really a budget issue, of course, but treating it as such prevents the possibility of a filibuster, to which budget resolutions are immune. If the resolution passes, leases would have to be granted, on the



Andy Goldsworthy, *Frozen river strong enough to walk on spread with snow cleared back to ice with hand to make a line began to thaw*, February 12, 1999

grounds that budget items must be reconciled with reality. Since the last elections thinned the ranks of senators opposed to drilling, many watchers expect such plans to move forward, despite what ought to be resistance from Democratic senators friendly to environmentalism, like Barbara Boxer of California and John Kerry of Massachusetts.

In 2001, as the debate about the refuge was making its yearly round through Washington and the media, members of Congress were provided with a report from the Congressional Research Service (CRS) that described the extraction technologies proposed for use in the refuge. The report, “Arctic Petroleum Development: Implications of Advances in Technology,” is for the most part optimistic about the industry’s ability to extract oil while minimizing environmental damage. It was prepared by Terry R. Twyman, a geologist and now a staff member of the American Petroleum Institute, which represents the interests of the oil and natural-gas industries.

The CRS describes itself as the “public-policy research arm” of Congress, charged with providing “nonpartisan, objective analysis and research on all legislative issues.” With a budget of some \$80 million, the CRS maintains a huge staff of analysts who produce reports on any topic that might be debated, ranging from problems facing mortgage funder Fannie Mae to homeland security. Its reports are available only to members of Congress but often make their way to the public anyway, usually through the offices of legislators who feel they stand to benefit from them. “Arctic Petroleum Development,” for example, can be found on the website of the American Petroleum Institute.

If Terry Twyman, having taken a job at the API, might be considered pro-oil, that does nothing to diminish the importance of the report, which more or less represents the industry’s best case. A look at this case may help clarify the issues involved, for anyone who is following the debate or simply trying to understand what the refuge may look like to the visitor in 2015.

Ice Roads for Thumper Trucks

When a new oil field is opened, each phase of its development—exploration, drilling, and production—may damage the landscape, and in each of these phases, technological improvements promise to reduce or eliminate that damage.

More particularly, exploration, as it is currently conducted, consists of building a map of subsurface data and then drilling. Acquiring that data can be disruptive. The crews needed often number more than 100, and they move across the landscape in container trains pulled by bulldozers. Depth soundings are initiated by “vibroseis” vehicles, multiton articulated trucks lugging around vibrating plates. The plates generate low-frequency signals detectable by “geophones,” microphones placed in a grid over several kilometers in rows as close together as a hundred meters. Sometimes known as “thumper trucks,” these vibroseis vehicles do not produce the portable earthquakes that have agitated the environmental lobby in the past, but they are still sizable rigs that must cover kilometers of ground within a huge network of geophones, each of which must be laid by hand.

The damage caused by moving such equipment about can be minimized, Twyman argues, by exploring the refuge during the

winter, when the terrain is frozen, and using Rolligons, vehicles with wide, balloon-style tires that would exert no more pressure on the tundra than a caribou hoof. (One industry photo even shows a Rolligon rolling over a smiling roughneck.) Coincident with the advent of the Rolligon has been the increasing use of ice roads on the North Slope. Ice roads are laid by Rolligons over the frozen tundra in mid-December and can support larger rigs pulling the mobile homes that house the crew. Drilling pads, too, can be built of ice. The oil industry contends that frozen roads and pads make the effects of exploration nearly invisible—all traces simply melt away—and believes that it can extend the drilling season further into spring by insulating the ice platforms.

Proponents also argue that the increasing accuracy of seismic data—which now yields 3-D rather than 2-D maps and can frequently be analyzed in real time by remote supercomputers—means that fewer soundings are necessary. The trade-off, however, is that although 3-D imaging reduces unnecessary drilling on what prove to be dry wells, it also requires the embedding of more microphones to obtain information in the first place. That, in turn, means more ground covered, with possibly harmful results. In any case, since the 1980s, advances in exploration technology have cut the number of wells needed to find oil in a field. This is good both for the oil industry’s bottom line and for the environment.

As the CRS report so baldly puts it, though, “there is no substitute, yet, for drilling” both for testing the hypotheses of computer modeling and for bringing oil to the surface. No substitute, but the number of wells needed to verify exploration and complete extraction can hypothetically be reduced yet further through a variety of drilling techniques, including directional, “designer,” and multilateral drilling.

In directional drilling, extended-reach drills and bits angle out from a single platform to reach widely separated reservoirs of oil, covering a horizontal distance that can be two to five times the wells’ vertical depth. In the North Sea, such wells have reached eight kilometers in length. Designer wells use bits that can make tight turns to avoid obstacles while drilling. Multilateral wells lead several horizontal branches off a single master well. With 3-D modeling, designer and multilateral wells can reach smaller and smaller pockets of oil. Drill bits have also improved. Made with diamonds, they have become harder, making drilling faster and allowing shorter times on site.

Drill holes, too, have gotten slimmer, which means fewer “cuttings”—the waste material that surfaces during drilling—and fewer personnel needed to handle the equipment and the waste. Some of the associated equipment can be transported by air, which lessens the need for new roads. A related advance is the development of coiled-tubing drilling, first used on the North Slope in 1991. Where traditional rigs might be 60 meters tall and use nine-meter-long sections of interlocking pipe, coiled-tube drilling employs flexible pipe that can be carried on a spool (sometimes brought in by air), which means holes drilled faster with less equipment and a smaller drilling platform.

Much is made of the “footprint” of an extraction operation—the area it takes up—and Twyman reports that, overall, that has been much reduced as well. Drilling, for instance, produces enormous volumes of by-products, including water, natural gas

trapped with the oil, and the cuttings fed up to the surface by a boring bit. These materials were formerly dumped into reserve pits six meters deep and around 4,000 square meters in area. Cuttings and water can now be pumped back into the ground. Furthermore, the water can now be separated from the oil while still underground, which alleviates the need for surface separation facilities. The general effect, industry contends, is smaller facilities manned by fewer men.

The Case against Drilling

Of all these technical advances, the environmental lobby, as might be expected, is skeptical. The Wilderness Society, for one, has published a report questioning pretty much every industry assertion about new drilling technology.

Environmentalists continue to doubt that Arctic exploration can be conducted with anything like minimal impact. Rolligons, they contend, are unlikely to work in the hilly terrain that characterizes much of the coastal plain; their low-impact tires simply will not propel them up a grade. Even ice roads, certainly the most elegant of industry solutions to environmental problems,

Clean technologies that significantly increase the cost of drilling will be shoved aside unless the administration mandates their use, which it will not.

are called into question. Environmental advocates point out that water is a limited resource in the Arctic refuge and is not, in any case, located close to likely oil fields. They also like to mention that global warming has dramatically shortened the arctic ice season. The environmental lobby fully expects that, if drilling is approved, industry will sidestep the Rolligons when needed by applying for exemptions and roll in heavier equipment.

As for drilling, environmentalists point out that directional wells on the North Slope have averaged around one and a half kilometers in length, reaching a maximum of six kilometers in one instance, and that they in fact turned out to be so expensive that BP abandoned them entirely in 2000. Environmentalists also doubt claims that exploration can somehow be confined to winter, pointing out that oil companies have never ceased production in the summer on the North Slope.

In these and other arguments, however, one begins to sense that environmentalists are not so much addressing the technologies themselves as industry's willingness to employ them, an interpretation borne out by the title of the Wilderness Society's report on the subject, "Broken Promises." The bulk of most environmental presentations, in fact, concerns not possibilities or drawbacks inherent in an approach like directional drilling but rather industry's poor record in employing old and new technology alike, complete with the usual photos of production facilities belching black smoke, the sprawling infrastructure at Prudhoe Bay, and roads crisscrossing the tundra. Environmentalists fully expect more of the same in the refuge.

More to the point, as environmentalists see it, the argument is not about technology at all. Fancy wells are still wells, less intrusive exploration is still intrusive, and pipelines remain pipelines (as well as the subject of the most laughably devious language in recent House bills regarding the refuge, which would limit the footprint of any industry activity—including the 150-kilometer or longer pipeline—to eight square kilometers but interprets the pipeline's footprint as that of the thin piers on which it would rest). None of these innovations, environmentalists contend, is compatible with wilderness, and they will turn a refuge into an industrial corridor.

It is not beyond the bounds of reason, however, to imagine that industry *could* drill with acceptably low impact. Man is an intelligent animal, after all, and ought to be able to remove oil from the ground without devastating the surrounding area. Less philosophically, the legal fines attached to environmental regulations are a mighty motivator. David Masiel, a former North Slope oilman, addressed this topic in a 2004 article in *Outside* magazine. He visited the North Slope and had conversations with drillers, executives, and enforcement officials. He found a new culture of cleanliness, mainly inspired by the threat of expensive lawsuits, to the point that drillers were actually baking gravel free of spilled oil. Writing for a magazine that has previously taken the administration to task for its environmental policies, Masiel concluded that drilling could be done in the Arctic with a tolerable level of damage—but only if clean drilling was legally enforced.

Secretary of the interior Gale Norton, in testimony before the House in 2003, emphasized that "the administration views tough regulation as an essential part of the ANWR proposal." But the administration has squandered its credibility there—something that may not have been apparent when Masiel took his trip in 2002—and has in fact been rolling back environmental regulations at a historically unprecedented rate. Areas designated as "roadless" in the Tongass National Forest in Alaska, for instance, are no longer roadless, and protections for wildlife across the United States have been greatly weakened, as bird watchers in New York recently discovered when a famous red-tailed hawk's nest was removed from a cornice by finicky apartment dwellers. Rules that have survived are simply not enforced: old cases have been dropped, and new ones are decreasingly pursued. It is only realistic to imagine that the same standards will be applied to the oil fields.

The technology for drilling with low impact may be available. Based on the administration's record of legislation and enforcement, however, it is unlikely that industry will be compelled to use it. Those technologies, such as coiled-tubing drilling, that have already proven themselves to be both environmentally *and* economically advantageous may be employed. Those that significantly increase the cost of drilling will be shoved aside unless the administration mandates their use, which it will not. Industry is not a moral being but an economic creature responding only to economic stimuli. As such, given the current balance of power in Washington, DC, there is good reason to conclude that big oil probably could drill clean, but probably won't. ■

Bryant Urstadt has written for Harper's, Rolling Stone, and the New Yorker. He lives in Guilford, CT.



Letter from Davos



The founder of *Red Herring* and AlwaysOn traveled to the World Economic Forum annual meeting and reported back to *Technology Review's* editor, Jason Pontin.

BY ANTHONY B. PERKINS

January 26, 2005

My dear Jason,

As you know from having made the pilgrimage before, the World Economic Forum adventure begins well before you arrive in Davos, especially if you are traveling all the way from California. Swiss International Air Lines stopped flying direct to Zürich from San Francisco, so I had to make two stops. This year I went through Washington, DC, an eventful choice because we picked up FCC chairman Michael Powell and the fur-coated secretary of labor, Elaine Chao. Secretary Chao is the highest-ranking U.S. official attending the WEF meeting this year. Interestingly, as a cabinet member, Ms. Chao traveled with three bodyguards, whereas Chairman Powell had none.

I have gotten to know Michael Powell pretty well over the last couple of years; he has been blogging for AlwaysOn for a while now. Michael was the first and is still the only major government figure to mix it up in the blogosphere, and he is good at it. Just prior to leaving for the forum, he announced that he would be relinquishing the job of FCC chairman in the spring, but he promised to blog on as a private citizen. "Blogging allows me to

step over the heads of the lobbyists and the Beltway press and go direct to the techies and get their unfiltered opinion," he beamed as we glided across the Atlantic. I told him that a third of his traffic comes from Howard Stern's website.

Touching down in Zürich does not mean the journey is over. One must still choose between a train (with two transfers along the way) or a WEF-sponsored bus. Both take the better part of three hours, and even then there is a taxi ride before you finally arrive at your snug hotel quarters in the sleek little ski village where the forum is held. This is your travel itinerary, of course, if you are *not* one of the Google founders who flew their shiny new jet to the forum this year. I am certain the boys skipped the bus ride and rented one of those black helicopters that for a few thousand bucks rocket you from the airport and plop you down in the village square in less than 20 minutes.

Like the rest of Old Europe, WEF has its own caste system that all attendees are well aware of but no one really talks much about. First you must get an invitation. The wizard of WEF, Klaus Schwab (founder and executive chairman), and his fabulously courteous yet inscrutable team of munchkins ultimately determine who gets to go. The supply of global players who want to attend far outstrips the supply of available spots, so one has to be either the president of a country, a monarch, the CEO of a big paying corporate sponsor, the editor in chief of a million-plus-subscriber publication, a Nobel laureate, a rock star, or Angelina Jolie. Politically astute smaller-company CEOs, venture capitalists, and other key influencers *can* get in, but that usually requires a powerful WEF member to whisper a personal recommendation into Klaus's ear. And even if Mr. Schwab gives you the nod, you still have to pay \$37,000 for your membership fee and \$28,000 for your annual ticket.

Paying members and corporate sponsors underwrite Klaus's impressive list of guest members, including leading artists, authors, scientists, scholars, and public figures. Huddled in the media corner with the CNN and BBC crews for much of today (we are "video-blogging" several of the main sessions), I watched a stream of world leaders drop by to smile for the cameras. It was like watching all the most talked about people in the world—the new Palestinian Authority's president Mahmoud "Abu Mazen" Abbas, President Viktor Yushenko of Ukraine, and Nobel laureate Shirin Ebadi—get interviewed in your own living room.

"Members" wear white badges that allow them to roam free, have tea in designated areas in the Congress Center, and sign up for special lunches and dinners held at the few dozen hotels that sprinkle the village. Your conference bag also comes stocked with an HP iPaq Pocket PC that provides wireless e-mail access to all attendees and the ability to remotely sign up for the private

Rarefied Air

**The annual meeting of the World Economic Forum, 2005
"Taking Responsibility for Tough Choices"**

Davos, Switzerland, January 26–30

events. Lower in the caste structure are the “working journalists,” who do not pay but must wear bright orange badges so world leaders know to watch what they say when they are around. If you are on the WEF staff, you wear a blue badge, and you are, more often than not, young, handsome or beautiful, and completely charming. I have to admit that, once you find yourself on the inside, as I have been blessed to be for the last nine years, it is a happy and orderly place, no matter your status.

The World Economic Forum’s mission is to “improve the state of the world,” which is lofty enough to satisfy the 2,000 global egos that fit into the main Congress Center every winter. Mr. Schwab also comes up with an annual theme, doing his best to capture if not influence the global zeitgeist. This year the theme was “Taking Responsibility for Tough Choices.” I never really figured out what choices we had made for which we now had to take responsibility, but Mr. Schwab did make a general call to “take immediate action on the tough issues of poverty, climate change, education, and equitable globalization.”

Of course, as seasoned attendees know, there is the stated theme, and then there is the real theme that emerges from the forum. The unwritten theme at the World Economic Forum annual meeting two years ago was “We do not like America.” The theme last year was “We still do not like America.”

In 2003, the meeting was held just over a month before the alliance went to war with Saddam. President Bush dispatched internationally popular secretary of state Colin Powell to Davos

that year. “Time is running out. We will not shrink from war if that is the only way to rid Iraq of its weapons of mass destruction,” Secretary Powell told a very skeptical crowd. In 2004, the Bushies dispatched Vice President Dick Cheney to Davos to assure folks that the U.S. wasn’t going to march the troops into Iran. “We’re hopeful [about] the effort by our European friends—the Germans, the French, and the Brits have been most directly involved—working with the Iranians, to try to get the Iranians to agree to a more intrusive inspection regime,” Cheney explained.

For an American, attending the forum in those years was a wearying and disheartening experience. In my view, the schism was about much more than the unpopularity of the Iraq War. The United States is the world’s sole superpower. The Iraq War was one example of how the U.S. can and will act unilaterally. That reality is understandably unsettling for many non-Americans.

This year, I was pleased to arrive in time to catch Prime Minister Tony Blair’s address. He is a splendid public speaker and was in top form as he defended President Bush’s call to advance Middle East peace. “America accepts that terrorism cannot be defeated by military might alone,” he promised.

Well, it has been a long day, and it turns out that President Chirac has bailed due to weather and is beaming in via satellite, so I am going to watch on the closed-circuit channel WEF provides on my hotel TV. Mr. Chirac is not a favorite of mine.

Your affectionate uncle, TP

Sergey Brin, Larry Page, and Ron Kok



My business partner Vassil Mladjov with Peter Gabriel



President Bill Clinton



Bill Gates, Prime Minister Tony Blair, and Bono



Reviews

January 27, 2005

My dear Jason,

I woke up this morning to read a report saying that after making his formal remarks last night, Mr. Blair put on a polo shirt and a pair of jeans and sat around his hotel suite drinking beer with a few reporters from the *Wall Street Journal*. He used the occasion to take another whack at explaining President Bush's foreign-policy vision, as part of a wide-ranging interview that appeared on the front page of the *Wall Street Journal Europe*. "I am shocked, occasionally, at how some people view [the U.S.] today," Prime Minister Blair told the editors.

By midday it was clear that Prime Minister Blair's remarks had made a powerful impact on the forum members. Even certified Bush bashers like Sun's chief researcher John Gage "loved" Tony Blair's remarks.

There was, of course, another big reason the WEFers weren't banging on America. Folks are too busy going gaga over the celebrities, including three of the biggest stars to have ever walked a red carpet: Sharon Stone, Richard Gere, and Angelina Jolie. True glamour has finally shined its light on Davos.

As I was hunkered down in the press lounge, I noticed this little Irish dude with sunglasses and hair slicked back who rushed by me with a blond babe trailing behind him. He had a leather jacket with fur sticking up around the neck, and his chest was all puffed up, and I started thinking, Hey, that guy walks like a rock star. Actually, the guy *was* a rock star: Bono. And if that wasn't enough, I looked up again and saw Lionel Richie. What is Lionel Richie doing here?

The beautiful people were here to use their star power for social change, of course. Angelina Jolie, who was called the "sexiest woman alive" on the cover of *Esquire* magazine, is all about drawing attention to humanitarian crises in Chad, Sudan, and Sierra Leone. Bono cares about poverty in Africa too, and Sharon Stone and Mr. Gere are all about raising money for the runaway AIDS epidemic. It was all so bright and glittery that I was truly at a loss as to what it all meant.

Thankfully, I ran into one of my Davos cronies, the other rock star in the house, Peter Gabriel, and asked him to sort it out. "I actually have a theory about that," Peter said, to my relief. "The role of celebrities is just like that of the Greek gods. When Margaret Thatcher was no longer our prime minister—and it is not like I agreed with any of her policies—I kind of missed her. But it was not about the Nanny State, it was about the Mommy State." Peter was getting a little Freudian for my taste by this point, but I encouraged him to go on. "Celebrities, Greek gods, Margaret Thatcher—they are like our parents. They protect us from having to look into oblivion. It is like having a golden roof over our heads. We look up to them so we don't have to face reality. It is a way to hide from our real fears."

Well, I could agree that Angelina Jolie was a Greek goddess. My business partner Vassil Mladjov and I watched her walk back and forth for interview after interview, always calm, collected, and stunning to look at. Even my wife, Nicole, chided me by phone from across the world; she said I should go up to Jolie, drop a few names, and try to get a snapshot. I am sorry to say I let us all down. It took all the courage I had just to take a photo of her on one of her many jaunts down to the press room. Later, I enjoyed hearing from Google CEO Eric Schmidt what it was actually like to sit next to the star of *Tomb Raider*. "She has this amazing, rather large forehead," he started. (Only a true geek would start out by marveling at a big forehead.) "And she has these lips that are almost surreal," said Eric. "God surely broke the mold, because there is no one like her," Eric concluded, and everyone listening nodded and giggled.

From my seat, Ms. Jolie looks like the real deal. After all, she did adopt a Cambodian orphan, she donates one-third of her income to charity, and she wins praise from United Nations officials for her hard work. Eavesdropping on her interviews, I heard her say, "Celebrities have the responsibility to know exactly what they are talking about and to be in it for the long run."

But Sharon Stone wasn't about to let Ms. Jolie steal all the headlines. Two hours after my chat with Peter Gabriel, in the midst of an earnest debate on "funding the war on poverty" in a packed Congress Hall, Sharon Stone suddenly rose to her feet



Vice Premier
Shimon Peres



Sharon Stone,
Michel Ogrizek,
and Richard Gere

and pledged \$10,000 to combat malaria in Tanzania, to the delight of the Tanzanian president, Benjamin Mkapa, who was one of the speakers. Stone then asked if others in the audience would care to help the cause. In the end, Ms. Stone's antics raised over \$1 million from 30 people.

By the evening, I was hanging with my Davos posse—Michael Dell, Accel Partners' Joe Schoendorf, Hasbro's Alan Hassenfeld, and novelist Paulo Coelho, the author of *The Alchemist*—at German media mogul Hubert Burda's party. Old Hubert holds his soirée at the Belvedere Hotel, and this year it was right next to the *Forbes* party. And I have to say Hubert kicked the American publisher's butt in both attendance and fun.

For the tech crowd, the big gossip in Davos was the meltdown of Hewlett-Packard's top dog, Carly Fiorina. Three successive bad articles in the *Wall Street Journal* and a trashing on the cover of *Fortune* made her dance like Michael Jackson. "I think the *Fortune* article was well done," Michael Dell told me. "But she is tough, so I don't think she is going down." I asked Michael if he thought that the HP-Compaq merger had been a failure. "I stand by my original position," he said. "The HP-Compaq merger was the best thing that ever happened to Dell." [At the request of HP's board, Fiorina resigned shortly after returning from Davos.]

As the end of the evening was upon us, I tucked myself into bed to rest up for the next full day.

Your affectionate uncle, TP

January 28, 2005

My dear Jason,

Tonight is the night for the annual Accel Partners/AlwaysOn/Google cocktail party at the wonderful Kirchner Museum, directly across the street from the Hotel Belvedere. My primary mission today is to remind everyone I see about the party.

But you asked me to write about the technology buzz here at Davos. A blogger at the forum reported that Eason Jordan, CNN's chief news executive, said that some journalists killed by the U.S. military had been deliberately targeted. The story is unclear because no transcript or video of the panel where Jordan was speaking has been released. I wasn't there at the time. But I am in the blogging business now, and my opinion is that we should cut poor Eason some slack. Bloggers have nothing to gain by looking like a bunch of vigilantes. [Bloggers' outrage at Jordan's remarks later forced the CNN executive to resign and has prompted much subsequent reflection on blogging's role in politics: see "Mean Media," p. 17.]

I think that, in terms of sheer impact, Bill Gates is the biggest celebrity at Davos. Just before Mr. Bill (who served as a cochair of the WEF meeting this year) showed up in Davos, the Bill and Melinda Gates Foundation announced that it was giving \$750 million over 10 years to the Global Alliance for Vaccines and Immunizations (GAVI). GAVI will use the new funds to improve the delivery of basic vaccines, such as those against diphtheria, measles, whooping cough, tetanus, polio, and TB. With an estimated 27 million children in the developing world going without

basic immunization each year, the World Health Organization estimates that \$8 billion to \$12 billion is needed.

For me, the highlight of Davos this year was sitting front and center in a packed press conference with Tony Blair, Bono, and Bill Gates. Gates is also on a mission to encourage folks like Prime Minister Blair to pony up for an international fund that could help pay for the distribution of these vaccines. At the conference, Bono praised the enormous contributions Gates has made to children in poor countries. It's true that Bill Gates deserves a lot of credit for getting the world to recognize that pharmaceutical companies view vaccine research as a low priority—at least when the target market is the developing world.

I have to admit, it is much more inspiring to listen to Bill Gates speak about world health-care issues than about IT. I swear I'll croak if he ever brings out that Tablet PC again. He's intellectually engaged in the medical research he's funding. As you know, Mr. Bill has been coming to Davos for years, and when here he likes to wear his foundation cap.

After edging my way out of the Gates press conference, I had to hustle over to the big party at the museum. Joe Schoendorf and I have been throwing the "Silicon Valley meets Davos" party for eight years. Google became a coconspirator two years ago. But while it may have a strong tradition, and Google makes us hip, it is Joe's wine selection that really attracts all the big dogs.

Given the recent tension over Middle East policy, we have hosted a nightcap discussion with Shimon Peres for the last two years. He was there again this year.

"Two years ago, one month before we went to war with Iraq, you said if Saddam did not give up, taking him out was going to be the right thing to do. Do you still think that was the right decision?" Joe asked the former Israeli prime minister. Peres stuck to his guns: "This was not a war about the religion of Islam; it was about fighting a terrorist state. The coalition had to move quickly against Iraq." Al Gore was sitting in the audience and was not too happy with what he was hearing from the man whom he had minutes earlier given a huge bear hug. Gore had his arms crossed and rolled his eyes.

So by the end of the evening, it felt as though the forum had come full circle and was focused back on Iraq. In two days the Iraqi citizens would have their first free election in more than a half a century. There was hope and promise in the air. I think the tragic tsunami that hit the Indian Ocean and surrounding countries a month earlier, and the outpouring of global support that followed, were also external events that helped shape the themes of this year's forum. They showed that if you bring enough media light to an issue, whether by the advent of a natural catastrophe, the smile of a Greek goddess, or a billion-dollar donation, the world can nudge those almighty rich countries to start giving to the poor countries in a big way. May God bless the world.

Your affectionate uncle, TP

Anthony B. Perkins was the founder and editor in chief of Red Herring magazine. Today, he is the editor in chief of the AlwaysOn Network, an online blog site for technology insiders, which he founded in 2002.

Freeze Frame

***The Polar Express* was a remarkable advance in digital animation. Why didn't audiences respond?**

BY WADE ROUSH

ONE OF THE advantages of being a technology journalist is that it gives you an excuse to buy the coolest new gadgets and go to the latest computer-animated movies without appearing to be an arrested adolescent. It was thus in a purely professional capacity that I settled into my seat one December evening in front of the 30-meter-wide Imax screen at San Francisco's Sony Metreon, a high-tech entertainment complex.

I was there to see *The Polar Express*, a rendition by director Robert Zemeckis of the lovely illustrated children's book of the same name. The movie tells the story of a young boy with doubts about the existence of Santa Claus. On Christmas Eve, a magical steam-locomotive passenger train arrives on the boy's street and transports him through snow-covered forests and mountains to the North Pole, where, of course, there really is a Santa.

The magic of the book is in the ravishing, otherworldly pastels by author-illustrator Chris Van Allsburg. I had heard about the computer wizardry poured into the film version—a digitized Tom Hanks plays six parts, including the boy and the train conductor—and I wanted to see how faithfully Zemeckis and his army of digital artists had recreated the look of Van Allsburg's illustrations. Also, I wanted to experience the film in 3-D, which is only possible in Imax theaters with special projection equipment.

I was expecting to get a little bit of diverting holiday entertainment. Instead, I received a pair of revelations. First, *today's 3-D projection systems really work*. Because the entire virtual world of *The Polar Express* was created in 3-D from the beginning, then flattened for presentation on regular screens, the depth of the scenes was far more palpable than what we've seen in previous 3-D experiments such as Disney's *Captain Eo*. Falling snow seemed to permeate the theater; oncoming locomotives made me want to jump out of my seat, like the people in Edison's first audiences.

The realism of the film's human characters provided my second revelation. If I squinted a little, the train conductor *was* Tom Hanks, down to his playful eyes and wrinkled brow. Rendering human characters via computer is a treacherous business; animation houses like Pixar have historically shied away from it, sticking to toys, fish, and the like. But for *The Polar Express*, Zemeckis decided to take a technique called motion capture to new extremes, suiting up Hanks and other actors with reflective markers and recording their every move and facial tic as they mimed their way through the action. (Data about the markers' positions provides a moving skeleton on which the character's digital skin, hair, and clothing can be hung.) I had never seen such realistic digital animation in an all-animated film, and I left the theater inspired by the realization that Hollywood's virtual tool kit was finally equal to any artist's imagination.



Reel Life

The Polar Express

Directed by Robert Zemeckis

Warner Brothers Entertainment, 2004

That's why I was puzzled by the chatter I found on the Internet about the supposedly "zombielike" mien of the human characters. The characters' eyes, for example, were alleged to lack some ineffable spark of life. And alas, the film did not turn out to be the holiday blockbuster Warner Brothers had been hoping for; its 2004 box office sales of \$161 million were respectable but far behind those of other computer-animated films, such as *Shrek 2* (\$441 million) and *The Incredibles* (\$258 million).

What went wrong? My guess is that moviegoers, perhaps misled by the film's prerelease hype or jaded by the breathtakingly lifelike Gollum in the *Lord of the Rings* movies, were expecting the movie's human characters to look as real as film actors. But that's not yet possible. In any case, that kind of verisimilitude would have marred the film. To tell an emotionally engaging story, Zemeckis needed characters just realistic enough to provoke empathy but not so realistic that the audience would lose the sense of being immersed in another world.

Given the resources now at animators' disposal, it would be a shame if the mixed success of *The Polar Express* led Hollywood to blacklist computer-generated humans. How else would we ever get to see waiters dispensing hot chocolate as they dance on the ceiling of a dining car, or Tom Hanks standing atop a derailed train that's raising a giant rooster tail of ice crystals as it careens across a starlit, frozen lake? ■

EDITED BY MONYA BAKER

Each month brings new investigative tools, new ideas for revolutionary technology, and revolutionary applications of existing technology.

No one can know today which will matter most tomorrow.

But these represent *Technology Review's* best prediction.

INFORMATION TECHNOLOGY

Dial-a-Virus

Hackers strike mobile phones

CONTEXT: Computer viruses and worms can be sent over mobile wireless networks almost as easily as text and voice messages, and any device that receives voice or data digitally is vulnerable. Some programs drain devices' batteries, disable buttons, or assail users with mobile spam; the more malicious ones steal information. David Dagon and his colleagues at the Georgia Institute of Technology and Virginia Polytechnic Institute and State University have created a taxonomy (a systematic classification) of mobile "malware" threats.

METHODS AND RESULTS: By sorting malware according to how it works, the taxonomy shows not just what kinds of attacks have occurred but also what kinds are possible. Its categories include the vulnerabilities that malware exploits (say, certain layers in a routing network) and the types of problems it causes. All existing malware causes semantic errors, a type of error that orders the mobile system to misbehave. The taxonomy shows that new attacks might exploit another class of errors, syntax errors, that confuse the phone by issuing orders it can't understand, causing the cell-phone equivalent of Microsoft's Blue Screen of Death.

WHY IT MATTERS: While mobile antivirus strategies will draw from their desktop counterparts, mobile protection algo-

rithms will need to be optimized for the lower CPU usage, higher power efficiency, and other idiosyncrasies of small devices. To prepare the best defense, engineers and end users need a map of the routes the enemy might take. That is what the taxonomy provides.

Source: Dagon, D., et al. 2004. Mobile phones as computing devices: the viruses are coming! *IEEE Pervasive Computing* 3:11-15.

Searching for Squishy Shapes

Vision algorithm models deformable objects

CONTEXT: To locate an object in an image, computer-vision algorithms often use mathematical models of the object's shape. But finding the boundaries of "deformable" objects, like human organs, is difficult, because the model must account for all of the objects' potential shape alterations. Algorithms that can pick out the edges of stretched or squashed objects are often inefficient; they require users or other algorithms to provide initial estimates of the objects' positions and orientations. Pedro Felzenszwalb of the University of Chicago has developed a deformable-shape model that helps locate such objects in images quickly and accurately.

METHODS AND RESULTS: Felzenszwalb's algorithm is able to represent any two-dimensional shape that contains no holes. Each shape is modeled by a collection of triangles that approximates the boundary of the undeformed shape. The algorithm assumes that some triangles can be distorted more than others, and that triangle edges at the boundaries of an object tend to coincide with changes in image brightness. To match the model to objects in the image, the algorithm deletes one triangle at a time from the model, transferring the information about its best-fitting deformations and image locations to a neighboring triangle. Once all the triangles are eliminated, the stored information can be used to quickly decide the area in the image that best matches the model. Thus, the algorithm can find the object without searching for every possible location, orientation, or deformation of the model.

Given information about how an object could be represented by triangles, the algorithm finds the object's boundaries in the image. Given a set of example shapes, the algorithm can also construct a general model for a class of objects, such as hands or leaves.

WHY IT MATTERS: Better modeling of deformable shapes increases the range of objects that computers running vision algorithms are able to automatically recognize. Felzenszwalb's method could thus be important for applications such as medical imaging and surveillance. It is as accurate as the leading methods for finding object boundaries in medical images,

Synopses

but it performs well without initially having to guess the object's location. Nor does the algorithm require the manual specification of parameters such as the amount of distortion allowed for each part of the shape; instead, it can learn from examples, which makes it easier to use.

Source: Felzenszwalb, P. F. 2005. Representation and detection of deformable shapes. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 27:208–220.

Wireless Lookout

Fast handoff for Wi-Fi networks

CONTEXT: People routinely access the Internet via the tens of thousands of Wi-Fi access points dotting airports, university campuses, cafés, and other public places. But a Wi-Fi device can connect to an access point only if it is close by—usually within 100 meters. When a device moves beyond the signal range of one access point, it is “handed off” to a nearer one, a process that disrupts data flow. For someone making a phone call over a Wi-Fi phone or watching live streaming multimedia, a one-second delay during handoff can be highly irritating. Ishwar Ramani and Stefan Savage of the University of California, San Diego, have developed a new approach, called SyncScan, that allows faster handoffs.

METHODS AND RESULTS: Right now, a Wi-Fi device searches for a new access point only after the signal quality from the one it's using degrades markedly. Then, the device scans all available wireless channels for beacons broadcast by access points, leaving little bandwidth for other incoming data.

With SyncScan, a Wi-Fi device regularly records the signal strengths of other channels, but it checks them only at the precise times that they are scheduled to transmit beacons. Such timing avoids needless channel switching, so the device receives more of the data being sent to it. It also makes better-timed and better-placed handoffs. In a prototype—a laptop computer running the popular In-

ternet-telephony program Skype—the delay during handoff was reduced a hundredfold to only a few milliseconds. The algorithm is expected to work for all Wi-Fi devices.

WHY IT MATTERS: Internet telephony and streaming multimedia are emerging as hot applications in Wi-Fi networks. Wi-Fi phones already exist in Japan and are expected in the United States by this spring, but long handoff delays will discourage their adoption. SyncScan shrinks the handoff delay without the need for hardware upgrades or changes to IEEE 802.11, the most widely deployed standard for wireless networks. Though SyncScan is still not perfectly synchronized, it promises to greatly improve the quality, convenience, and value of communication in Wi-Fi networks.

Source: Ramani, I., and S. Savage. 2005. SyncScan: practical fast handoff for 802.11 infrastructure networks. *Proceedings of IEEE Infocom 2005* (in press).

Managing Memos

A smarter interface for e-mail

CONTEXT: Many people and businesses rely almost entirely on e-mail to manage diverse transactions. But e-mail programs are optimized to manage messages, not to-do lists. Technologies to make e-mail more useful have tried aggregating messages that have a common header or tagging messages as associated with specific, predefined tasks. A new way to free workers from sifting through copious messages—a machine-learning algorithm that automatically keeps track of tasks, and which e-mails are associated with them—hails from Nicholas Kushmerick at University College Dublin and Tessa Lau at IBM.

METHODS AND RESULTS: First, the algorithm groups e-mails according to the transactions they're part of, which it deduces by identifying, say, order numbers or clients' names. Next, messages are

grouped by the events they represent, such as shipping notifications or order confirmations. Combining these two perspectives, the algorithm looks for common patterns, or workflows, that recur across a given set of transactions. For example, e-commerce transactions typically involve order notification, shipping notification, and messages about delayed or modified orders.

On the basis of such patterns, the algorithm automatically determines the status of a given transaction. Without requiring user input or manually labeled examples, the algorithm correctly identified the transaction stages represented by 101 out of 111 messages in an e-commerce test set representing 39 transactions by six vendors.

WHY IT MATTERS: A 2003 survey of major industries found that more than 90 percent of organizations use e-mail to respond to customer inquiries, and about 70 percent use e-mail for invoicing and contract negotiation. Kushmerick and Lau envision their algorithm as the core of an interface that automatically organizes e-mail by task as easily as by date or sender. By learning workflows, the algorithm can facilitate even specialized processes, which gives it an advantage over techniques that rely on message headers or preformatted content. Eventually, this technique and others like it should help convert cluttered in-boxes into a set of well-oiled workflows.

Source: Kushmerick, N., and T. Lau. 2005. Automated e-mail activity management: an unsupervised learning approach. *Proceedings of the 10th International Conference on Intelligent User Interfaces*, pp. 67–74.

BIOTECHNOLOGY Old Drugs, New Tricks

Cholesterol and cancer drugs may fight Alzheimer's

CONTEXT: Often a drug that treats one disease works for another, apparently unrelated disease. Two early antidepressants

began their careers as an antibiotic (iproniazid) and an antihistamine (imipramine). The impotence drug Viagra was designed to prevent heart failure. Now, two recent papers report that drugs already on the market may help prevent Alzheimer's disease.

METHODS AND RESULTS: Some studies have found that patients taking statins, a class of cholesterol-lowering drugs, are less likely to develop Alzheimer's disease. A team led by Sam Gandy at the Farber Institute for Neurosciences at Thomas Jefferson University in Philadelphia sought an explanation of this finding. It turns out that when statins are added to cultures of neurons, the neurons more quickly destroy a precursor of the protein amyloid that goes on to form the plaques characteristic of Alzheimer's. To determine exactly what statins do in neurons, Gandy's team both blocked and mimicked their effects by manipulating proteins—and so showed which proteins the statins affect.

Taking a different tack, a University of Pennsylvania School of Medicine team led by John Trojanowski, in collaboration with Angiotech Pharmaceuticals, tested the cancer drug paclitaxel in mice genetically designed to have neurodegenerative disease. Paclitaxel halts cell division, causing cells to die. It does so by binding to and preventing the movement of microtubules, structures that form cells' support and transport infrastructure. For diseased neurons, however, this stabilizing effect proved beneficial. In mice, the drug partially restored nerve function, apparently substituting for a protein, tau, that normally stabilizes microtubules in nerve cells but malfunctions in Alzheimer's disease.

WHY IT MATTERS: Alzheimer's disease is the leading cause of dementia in the elderly, but current treatments do nothing to halt the disease; they simply alleviate its symptoms, often insignificantly. Other experimental therapies directly target amyloid or closely related molecules.

The Penn and Jefferson researchers' results point to possible new approaches to combatting the disease, ones that might prevent plaques from forming in the first place. Though this research is

still in its early stages, its basis in widely used and studied drugs should help speed its progress.

Sources: Zhang, B., et al. 2005. Microtubule-binding drugs offset tau sequestration by stabilizing microtubules and reversing fast axonal transport deficits in a tauopathy model. *Proceedings of the National Academy of Sciences* 102: 227–251.

Pedrin, S., et al. 2005. Modulation of statin-activated shedding of Alzheimer APP ectodomain by ROCK. *PLoS Medicine* 2: 69–78.

Gene Control

New gene-regulating enzyme found

CONTEXT: The Human Genome Project catalogued our genes, but all that genetic information is useless unless it's tied to physical traits. One of the biggest remaining questions in biology is simply how genes are turned on and off. Part of the answer lies inside the cell's nucleus, where DNA is wrapped around spool-like structures called histones. In the late 1990s, researchers found that enzymes placed chemical tags on the spools and that these tags could activate or deactivate genes on the wrapped DNA. What the researchers couldn't find were enzymes that removed the tags, leading many to conclude that they just didn't exist. A team at Harvard Medical School and Johns Hopkins School of Medicine led by Yang Shi has now found such an enzyme, and with it a new layer of gene control not previously exploited by medicine.

METHODS AND RESULTS: Shi's team was not originally looking for a detagging enzyme. Instead, it was investigating how the enzyme LSD1 (important for embryonic patterning and differentiation), as part of a larger protein complex, manages to suppress huge families of genes. After several experiments, the team realized that when LSD1 wasn't around, certain genes were expressed because a histone that should not have been tagged in fact was. Closer observation of cells in which LSD1 was present revealed remnants of removed tags, confirming the enzyme's

behavior. It also showed that LSD1 clips tags at very specific spots, thereby exerting control over a discrete set of genes.

WHY IT MATTERS: Improperly tagged histones are implicated in several types of cancer. The discovery of this enzyme solves the second half of a mystery in gene regulation. Controlling this and related enzymes could lead to new therapies, particularly for cancers such as leukemia and neurodegenerative diseases. Further off, the enzyme could be used in bioengineered cells to turn large swaths of genes on and off without interfering with other techniques of gene regulation. Shi's group has submitted a patent application on LSD1. Now, the search begins for more such enzymes.

Source: Shi, Y., et al. 2004. Histone demethylation mediated by the nuclear amine oxidase homolog LSD1. *Cell* 119:941–953.

Silicon on the Brain

A chip that reads neurons

CONTEXT: The neurons of the mammal brain are hard to study, even when they're isolated in the lab. For more than a decade, scientists have analyzed the large neurons of leeches and snails by linking them directly to silicon chips that record their electrical activity. But mammalian neurons are smaller, and though they can be grown on silicon, the resulting signals are typically too weak to yield useful data. The electrical activity of mammalian brain cells can be read with electrodes, but that can be imprecise and requires careful preparation steps.

Moritz Voelker and Peter Fromherz at the Max Planck Institute for Biochemistry have now designed the first computer chip that can record the firing of mammalian neurons, though so far only in a petri dish.

METHODS AND RESULTS: As a neuron fires, the voltage across it changes, so a neuron on a chip affects how transistors underneath it conduct electricity. But in chips with conventional transistor designs,

there's so much naturally occurring noise that it swamps neural signals. So Voelker and Fromherz changed the geometry of the transistors to suit the electrical properties of living neurons. They buried the conducting channels of their transistors a few nanometers deeper than usual, making the transistor more sensitive to the low voltages and firing speeds of neurons. The transistors could detect the signal of an individual rat neuron in a group, without the elaborate sample preparation that conventional electrodes require. What's more, the transistors are significantly smaller than individual neurons and could in principle provide information on how subsections of a neuron behave.

WHY IT MATTERS: Electrodes implanted in human brains have allowed paralyzed patients to move computer cursors and prosthetic limbs (see *"Implanting Hope," March 2005, p. 48*). While increased computing power helped enable that breakthrough, so too did the development of hardware suitable for detecting neural signals. A silicon interface could process data more nimbly and is the logical candidate for next-generation devices. Those are still years away; in the nearer term, neuron-silicon interfaces will help explain how groups of neurons communicate with each other and could be particularly helpful for understanding how neuroactive drugs such as antidepressants work.

Source: Voelker, M., and P. Fromherz. 2005. Signal transmission from individual mammalian nerve cell to field-effect transistor, *Small* 1:206–210.

NANOTECHNOLOGY Molecular Manufacturing

A machine built out of DNA

CONTEXT: Deep in every cell, miniature biological machines called ribosomes forge proteins. Following instructions written in our genetic code, ribosomes weld together amino acids to form the enzymes that modulate body chemistry and the structural materials, like collagen, that

hold the body together. As good as engineers are at building machines and structures on the scale of people, they have few tools for building on the scale of molecules, as a ribosome does.

Researchers from New York University have taken a landmark step toward the goal of imitating the ribosome, building a programmable, nanoscale machine that can weld together DNA molecules.

METHODS AND RESULTS: NYU chemists Shiping Liao and Nadrian Seeman twisted and bent DNA to build a structure that is approximately 110 nanometers long, 30 nanometers high, and 2 nanometers thick, roughly the same size as a ribosome, though not as complex. Just as the ribosome can be programmed to weld amino acids together in a prescribed sequence, this DNA machine can be instructed to select specific small molecules of DNA for concatenation. The DNA machine can swivel into four geometric positions and can be locked into any one of them by another fragment of DNA, the "instructions." Locking the machine into position dials in the sequence of very short DNA strands that it will recognize and position for welding. The welding itself is performed by an enzyme that links DNA molecules. In the absence of the machine, this enzyme would create many different combinations of DNA strands; in its presence, only a single, preprogrammed combination results.

WHY IT MATTERS: The evolution of the ribosome transformed terrestrial biology, enabling cells to manufacture any protein of any size or shape as needed. Nanotechnologists seek a similar watershed, the development of a machine that could make improved pharmaceuticals or biomaterials. Liao and Seeman's approach could also be extended to the manufacture of nonbiological products, with the goal of producing materials that are impossible to construct using conventional chemistry. Measured against these ambitions, their current nanodevice appears crude, but it is likely to be followed by more sophisticated successors.

Source: Liao, S., and N. C. Seeman. 2004. Translation of DNA signals into polymer assembly instructions, *Science* 306:2072–2074.

Twice as Light

Double layering boosts organic-solar-cell efficiency

CONTEXT: Solar cells offer the promise of clean, renewable energy. But most cells in use today use silicon to absorb light, which makes them brittle and so expensive to manufacture that it takes years before they produce enough electricity to recoup their cost. Enter organic solar cells, which use carbon-based molecules such as "buckyballs" rather than silicon. In theory, cells made from these cheap, flexible materials could be rolled out in sheets of translucent plastic and stuck on everything from cell phones to clothing. But while commercial silicon-based cells can convert about 20 percent of the sunlight that strikes them into electricity, organic cells typically convert only 1 or 2 percent. Stephen Forrest's team at Princeton University has developed a new way to boost that average.

METHODS AND RESULTS: When light interacts with a solar cell, different wavelengths deliver more or less energy at different depths. By varying the composition of their organic solar cells, the Princeton researchers tuned some to more efficiently absorb reddish light and others to absorb bluish light. They then layered the red cells onto the blue, to capture those wavelengths of light where they are most intense. The result: an efficiency of almost 6 percent, the highest published for such cells to date. The researchers speculate that with a third layer (say, for infrared wavelengths), the cell could reach double-digit efficiency.

WHY IT MATTERS: Organic solar cells may be cheap and widely applicable, but with their current efficiencies, even plastering the side of a skyscraper would not yield enough power to be practical. The jump in efficiency reported by the Princeton team—plus innovations in manufacturing and integration—makes the prospect of generating municipal power from these renewable solar sources more likely.

Source: Xue, J., et al. 2004. Asymmetric tandem organic photovoltaic cells with hybrid planar-mixed molecular heterojunctions. *Applied Physics Letters* 85:5757–5759.

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Technology as Hope

At a time of despair, the 1930s world's fairs glorified technology as the way of the future

TECHNOLOGY HAS BEEN an important part of world's fairs since the first one in London in 1851, where agricultural reapers and Colt's revolvers were on display. But at the world's fairs in Chicago in 1933 and New York in 1939, technology gained far greater prominence, with spectacular, larger-than-life exhibits that showcased the latest in manufacturing and communications. Even though the country was still in the depression and admission prices were high (50 cents in Chicago and 75 cents in New York), the events were enormously successful, together attracting more than 90 million visitors.

Inventors had always flocked to world's fairs to show off their latest inventions. Automobiles, telephones, and electric lights all made their major public debuts at fairs before the 1930s. "If you were an inventor or manufacturer and you were trying to introduce a product or idea to the masses, a world's fair was a pretty good way to do it," says Robert Rydell, a history professor at

Montana State University. But during the depression-era fairs, organizers gave scientists and corporations an opportunity to present technologies integrated into visions of a more prosperous future.

The 1933 Chicago World's Fair, whose theme was the "Century of Progress," stood out because of the unprecedented influence that scientists and engineers had in its planning. Led by Frank Jewett, chief engineer and vice president of American Telephone and Telegraph (AT&T), American scientists seized on the event as a chance to improve the image of technology. Exhibits included a working auto assembly line, a working model of an oil refinery, and cable cars that looked like rockets and that were suspended 60 meters off the ground. Displays devoted to math, physics, chemistry, biology, and geology were housed in the U-shaped Hall of Science, the fair's largest exhibit building. Outside the Hall of Science was a statue depicting a robot pushing a man and a woman forward with its hands.

Companies spent millions of dollars at the 1930s fairs to install exhibits that trumpeted the power and promise of industry. At the 1939 New York "World of Tomorrow," the list of companies showing off their newest products included all of the major carmakers; Kodak, which was demonstrating color photography; AT&T; General Electric; the Radio Corporation of America (RCA), demonstrating television; and Westinghouse, which displayed a seven-foot-tall, cigarette-smoking robot called Elektro the Moto-Man. DuPont unveiled the world's first synthetic fiber, nylon, in front of 3,000 women's-club members.

But the most popular exhibit was the Futurama at the General Motors pavilion, which attracted almost 27 million visitors, many waiting in line for as long as two hours. Visitors seated in moving chairs equipped with built-in, individual sound systems peered over a futuristic model of an American city in 1960, neatly crisscrossed by well-engineered seven-lane superhighways that permitted automotive speeds of up to 100 miles per hour. The exhibit was a marketing coup for the largest automaker. According to Rydell, the enthusiasm created by Futurama helped push the federal government to build a national highway system, which it did in the 1950s.

The next world's fair wouldn't take place until 1958 in Brussels, Belgium. The Cold War was under way and the specter of nuclear weapons hovered over everything. The sobered mood was obvious in the Brussels fair's theme: "Building the World on a Human Scale." By the early 1960s, however, the space race had begun, and world's fairs reflected a renewed optimism about technology. The futuristic-looking Space Needle symbolized the 1962 fair in Seattle, and at the 1964 fair in New York City, GM's Futurama exhibit returned, this time featuring lunar travel, underwater resorts, and solar energy.

World's fairs are still going on today: the 2005 World Exposition in Aichi, Japan, began last month. But with so many other means of marketing and learning about new technology available, world's fairs have never recaptured the excitement and hope they once generated for millions of depression-weary visitors. **CORIE LOK**




Visitors take in the popular Futurama exhibit at the 1939 New York World's Fair.



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